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MONGOLIA THE NEW WORLD

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Part I

When Roy C. Andrews made his first journey to Mongolia in 1916 he could hardly have dreamed of the far-reaching scientific results that would eventually grow out of his determination to explore the Gobi region on a larger scale. For since then he and his associates of the Third Asiatic Expedition of the American Museum of Natural History have literally opened up a new world to science. All previous explorers had reported the Gobi desert as barren of fossils, but Andrews and his colleagues have discovered a long series of fossil-bearing basins representing many millions of years and containing a superbly preserved record of animal life. The geologists and geographers of the expedition, mapping every mile of the thousands traversed by the expedition, photographing and drawing the present topography of the mountains and great basins and collecting an equally full series of rock samples for laboratory sectioning and analysis, have literally brought home the record of the entire earth history of northern Asia; meanwhile the archeologists of the expedition have recovered highly significant relics of prehistoric man.

Now that a considerable part of the Third Asiatic Expedition's collections have been worked out of the rock and the specialists have published a series of technical reports upon their results to date, it seems timely to attempt a broad general account of these discoveries and to indicate how they may be connected with similar investigations in other parts of the world.

The Peneplanes of Mongolia

The "peneplanes of Mongolia," as described by Professor Berkey and Dr. Morris, may well be selected as the take-off for our airplane survey of the country. Whenever the rock strata of the earth's outer crust become crumpled up into mountains, or whenever a given region is "block-faulted" upward, the increase in general level of that region rejuvenates the forces of erosion. Heat and cold, moisture, frost, wind and rain, all aided by gravitation, renew their age-long work of breaking and pulverizing the rock, of scouring river channels and of carrying the detritus down to lower levels until it is swept out to sea, there to form great sedimentary beds of sandstone, limestone, etc. As long as there is no further general disturbance of level these processes continue to wear down the mountains and uplands. Meanwhile the gradients, or general slopes of the rivers, are being reduced, the rivers become too sluggish to carry their full loads of sediment down to the sea and the lowlands become filled up with the sediments brought from the uplands, until the "base level of erosion" is ap-

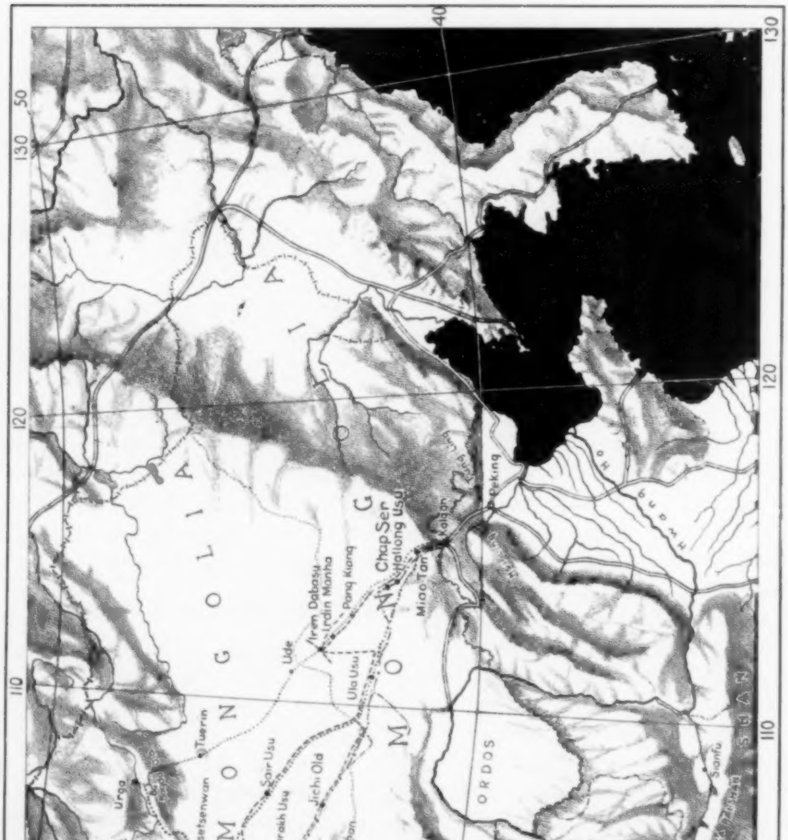


FIG. 1. MAP OF CENTRAL ASIA

The mountains are shaded as though the light were falling from the upper left-hand corner, while the basins are left white. The mountain rim encloses the Mongolian basin so that almost none of the rivers reach the sea. During past ages such inland-flowing rivers have carried down to the center of the basin the sediments in which the fossils are found. Djadokhta is at Shabarakh Usu.

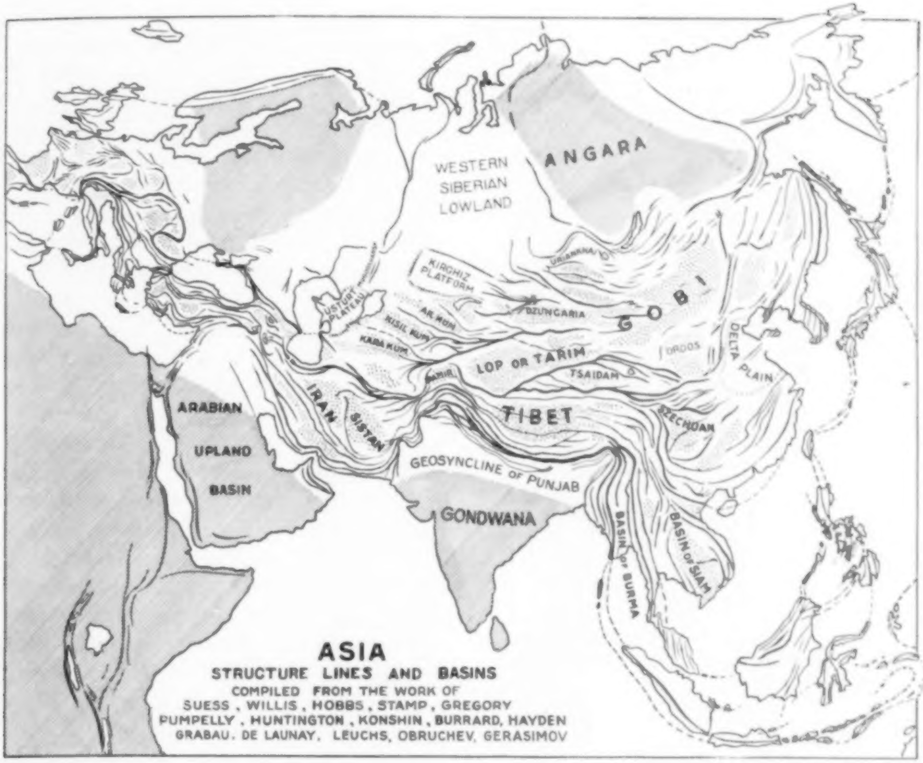


FIG. 5. MAP OF ASIA, SHOWING THE TREND OF MOUNTAIN RANGES, AND THE POSITION OF THE GREAT BASINS.

LARGE POSITIVE ELEMENTS ARE SHADED IN SLANTING LINES. THE GREAT STRUCTURAL BASINS ARE STIPPLED.

proached and the general surface is gradually levelled down into a "peneplane" or nearly flat surface. Whenever a new uplift occurs the old base level is changed and the forces of erosion begin to destroy the old peneplane and to build up a new one on a different level.

Drs. Berkey and Morris show that as the traveller proceeds from the "Arctic divide" in the Khangai Mountains in north-central Mongolia in a southeasterly direction toward Peking, he passes across five general levels in descending order. The highest is the "Arctic divide" and the remnants of the "Khangai peneplane," which is a broad, gently-rolling surface surmounted by low, rounded hard-rock hills or monadnocks; next comes the "Mongolian peneplane," which may prove to be a down-warped extension of the Khangai peneplane. Descending from the Mongolian peneplane one comes out upon the vast level floor of the "Gobi peneplane"; this is a surface of extraordinary smoothness which bevels the tilted and faulted strata of many geological ages. The geologists have not yet settled whether the planing force that produced the Gobi peneplane was blowing sand or whether the effect was the work of water in a past cycle of more humid condition.

In another communication Drs. Berkey and Morris point out that the Gobi peneplane is the easternmost of a series of great interior basins of Asia, including the Dzungaria, the Lop, the Balkash and Aral-Caspian and others, which are semi-arid steppe countries, including desert ranges, broad open minor basins

FIG. 2. DISTANT VIEW OF THE KHANGAI PENEPLANE.

The figure is part of a large field sketch made near Sain Noin Khan, looking northward over two intervening mountain ridges to the Arctic divide, which forms the skyline. The peneplane is a broad, gently-rolling surface, above which rise low monadnocks. Several glacial cirques are seen, but the glaciation was not severe.

and occasional depressions with lakes and salt pans. The Gobi has a width of roughly five hundred miles north and south and a length of one thousand miles east and west. The entire country from the southerly margin to the Arctic divide is warped into a broad open syncline, or gently-sloping concavity, whose central portion is three thousand feet lower than the outer margins. Thus the rims of the basin stand from five to seven thousand feet above the sea and the broad downwarped expanse between forms a basin-shaped plateau, parts of which are real desert.

The great basin of the Gobi contains many minor basins which the authors call "talas," from a Mongol word for an open steppe country. Thus we reach the fourth level from the top. Each tala, the explorers tell us, has its own local interior drainage and is bounded by inconspicuous warp divides or by mountain ranges, or both, separating it from neighboring areas of similar habit. Within each tala there are still smaller basins, called by the Mongols "gobis" and it is in these smaller gobis that the explorers discovered a great series of sedimentary formations representing many different horizons—from the Cretaceous beds containing the famous dinosaur eggs, at the bottom, through ascending levels of the Age of Mammals, containing many fossil remains of mammals, and culminating at the top in the loess deposits of glacial and post-glacial times. Thus we obtain the picture of a descending series of vast peneplanes and of basins within basins, the principal fossil-bearing strata being found in the lowest basins.

The Oldrock Floor and the Great Mongolian Bathylith

The fossil-bearing strata of the talas cover periods of millions of years in duration, yet they represent only the later stages in the history of Mongolia. Beneath the nearly horizontal sedimentary strata of the lowest talas, and in many other places where the later rocks have been cleared off by wind and water,

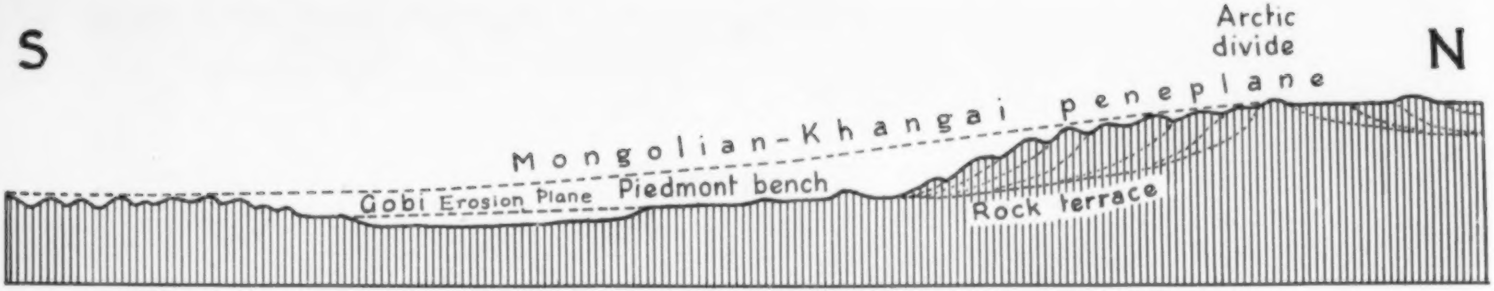


FIG. 3. RELATIONS OF THE PENEPLANES

DIAGRAM SHOWING THE KHANGAI PENEPLANE AT THE NORTH, WARPED DOWNWARD SO AS TO FORM THE MONGOLIAN PENEPLANE IN THE SOUTH.

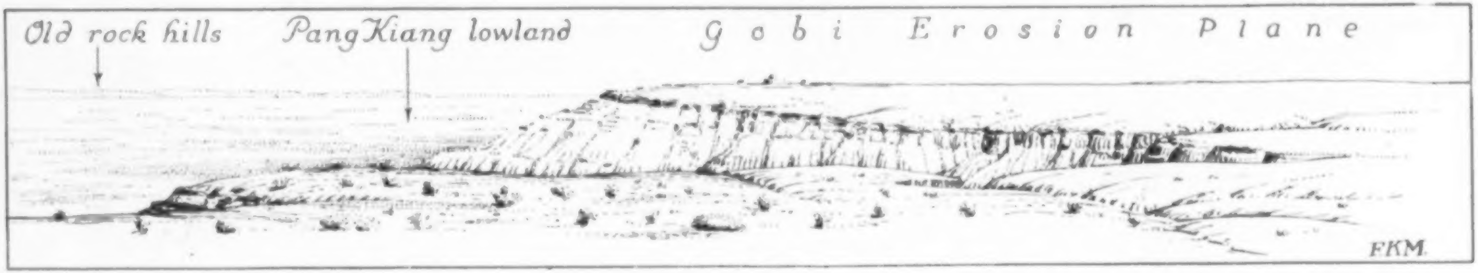


FIG. 4. FIELD SKETCH OF THE GOBI EROSION PLANE AT ARDYN OBO, LOOKING EASTWARD

THE SKETCH SHOWS: (1) THE REMARKABLY LEVEL SURFACE OF THE GOBI EROSION PLANE, BEVELING STRATA THAT ARE SENSIBLY HORIZONTAL; (2) THE LOWLAND OF THE PANG KIANG STAGE AT THE LEFT; (3) THE BADLAND BLUFFS DESCENDING ABOUT 300 FEET FROM THE GOBI UPLAND TO THE PANG KIANG LEVEL; (4) THE REMARKABLE SHORTNESS OF THE GULLIES OF THE DISSECTED ZONE, IN CONTRAST TO THE GREAT AREA OF THE PANG KIANG LOWLAND.

DINOSAUR EGGS WEATHERING OUT OF THE ROCKS

THE BLOCK OF SANDSTONE JUST BEHIND THE VISIBLE EGGS WAS QUARRIED OUT AND FOUND TO CONTAIN A COMPLETE NEST OF EGGS.

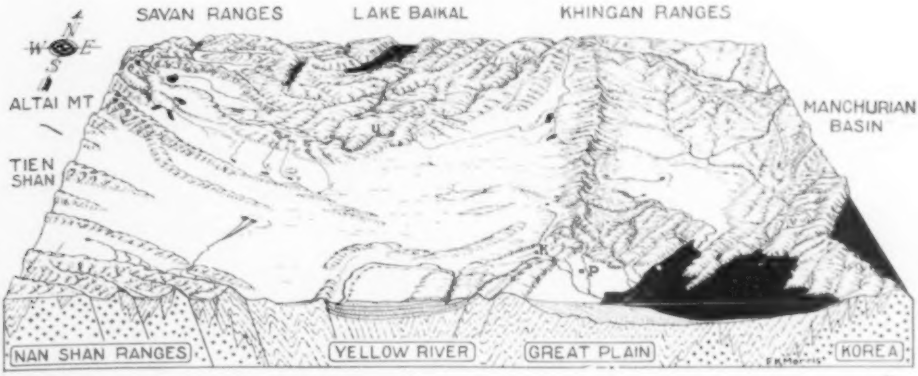


FIG. 6. PERSPECTIVE SKETCH OF MONGOLIA AND MANCHURIA.

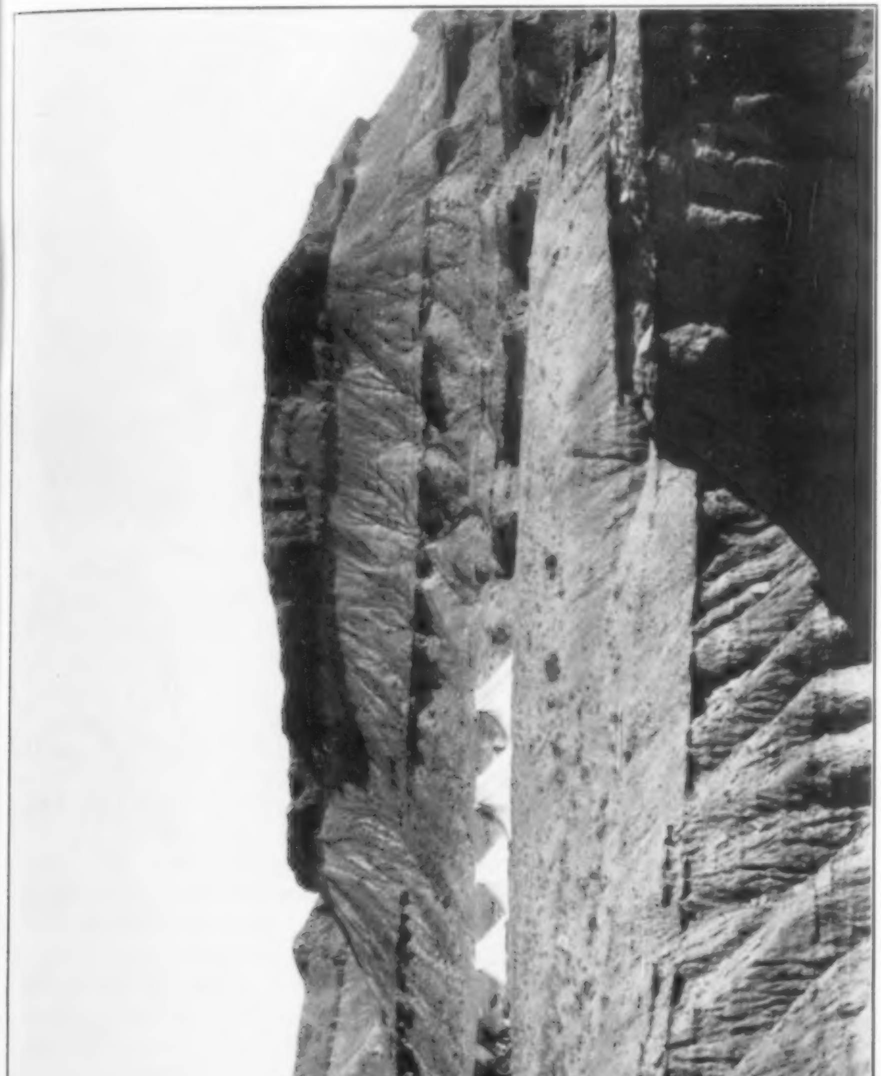
THE DRAWING REPRESENTS A BLOCK CUT OUT OF THE EARTH'S CRUST, SHOWING THE STRUCTURE OF THE ROCK FORMATIONS ALONG THE CUT EDGE. BOTH COUNTRIES ARE SHALLOW BASINS SURROUNDED BY MOUNTAINS. THE BASINS ARE SEPARATED BY THE GREAT KHINGAN RANGE, WHOSE STEEPER SLOPE IS TOWARD THE EAST. THE SEDIMENTS WHICH HAVE WASHED INTO THE MONGOLIAN BASIN IN LATE GEOLOGIC TIME CONTAIN THE FOSSILS OF CREATURES WHICH LIVED THERE WHILE THE SEDIMENTS WERE BEING DEPOSITED. THE LETTERS, P, K, U, STAND FOR PEKING, KALGAN, AND URGA RESPECTIVELY.

we find what the geologists call the "oldrock" floor of the great Gobi basin and the detailed study of this oldrock floor has revealed a picture of surpassing grandeur. All the millions of years represented by the rocks above the oldrock floor are as a watch in the night compared to the age of the oldest strata in the oldrock floor itself; all the warpings and deformations in the later rocks record only feeble stirrings of the vast plutonic forces beneath, compared with the terrific disturbances of the earth's crust testified by the presence of what the authors have named the "Great Mongolian Bathylith." This huge mass of granite underlies thousands of square miles in Mongolia. Its upwardly-growing roots penetrate the later rocks like writhing serpents of congealed fire. For millions of years after its first great outburst this immense reservoir of molten rock enjoyed occasional periods of rejuvenescence and at such times it played havoc with the older sedimentary rocks saturating them with its own living fire and often leaving them in a highly altered condition.

Naturally the geologists sought for evidence which would enable them to determine the relative age of the bathylith as compared with other rock systems of the oldrock floor and thus to assign it to its rightful place in the standard geologic column of rock formations. At a certain point in the oldrock floor of the Gobi desert, about one hundred and twenty miles southwest of Iren Dabasu, the geologists came upon a series of marine sedimentary beds containing invertebrate fossils. Professor Grabau later determined these fossils to be of Permian age, since they were specifically identical with fossils of known Permian age from China. In the same place the explorers noted an outcrop of granite, presumably from the Great Mongolian Bathylith, which appeared to be "faulted" against the Permian strata. From the fact that the Permian beds near the contact with the granite are not metamorphosed (as they would have been if they had been present when the granite was molten) and from the further circumstance that no dikes or offshoots from the granite were seen penetrating them, the geologists infer that at least in this region the granite is older than the Permian beds. On the other hand, the bathylith penetrates and undercuts the "Khangai graywacke-slate series" in the northern mountain area one hundred miles south-

CHIONJI BLUFFS AT DJADOKHTA

THEY CONSIST ALMOST WHOLLY OF FINE RED WIND-BLOWN SAND, IN WHICH THE DINOSAUR EGGS WERE FOUND.



RED MESA AT OSHIH

THE CAP IS BLACK BASALT IN WHICH WERE FOUND NUGGETS OF AGATE WHICH WERE USED BY PREHISTORIC MAN TO MAKE STONE IMPLEMENTS. IN THE CANYON BELOW THE CAMP THE BONES OF THE OLDEST DINOSAURS OF MONGOLIA WERE FOUND.

UNEARTHING SKELETONS OF IGUANODONTS AT IREN DABASU.

west of Ugra and the graywackes are locally metamorphosed by contact with the granite over a wide territory. Hence the bathylith, at least in this phase, is younger than the graywackes. These in turn on various grounds are judged to be of late Proterozoic age. Thus the upper and lower limits of the age of the bathylith were determined, at least approximately.

As the graywackes and their associated beds of slates, jaspers and quartzites are older than the Great Mongolian Bathylith, so certain other components of the oldrock floor of the Gobi region are older by far than the graywackes. In some places a series of schists, phyllites, limestones, dolomites, quartzites and greenstones appear to represent the "Wu T'ai system" of China, which is classed as early Proterozoic in age, while a still older series of crystalline limestones, schists and complex injection-gneisses seem to be akin to the "T'ai Shan complex" of China, which represents the Archeozoic or Archean rocks of America and Europe. Great beds of conglomerate in these series are taken to indicate periods of emergence and rapid erosion.

Thus we see that the early history of Mongolia was broadly similar to that of other great land masses such as Europe and North America; that is, for tens of millions of years the land would be sunk beneath the sea and be deeply covered with marine deposits, then there would be long periods of emergence with great outbursts of granite and lava, the crumpling of strata into mountains and troughs, followed by deposition of epicontinental sediments and the slow process of peneplanation; then again the long cycle of subsidence and marine deposition, with subsequent uplift.

As noted above, all the rocks in the oldrock floor of the Gobi region are much folded over wide areas, but above the floor the warping and folding of later strata are but slight and local. Not since the middle of the Age of Reptiles did the sea flow over central Mongolia or drown its inhabitants in a great flood. The chief fossil-bearing formations of the Gobi desert are all of continental type and Mongolia for millions of years of its later history has been the secure home of many races of reptiles, mammals, perhaps even of the ancestors of man himself. From its windswept highlands it has sent forth its caravans and invading hordes in the Age of Mammals no less than in the days of Genghis Khan.

FORMATION OF THE MOON AND EARTH

By W. L. R. EMMET

THE GENERAL ELECTRIC COMPANY

THE idea that the markings on the moon's surface have resulted from impact of bodies drawn into it, rather than by volcanic action, has in recent years been advanced and discussed by various persons and there seems to be a growing tendency to belief in that theory. The author of this article wrote a paper on the subject in 1907 which may have been among the earlier discussions of the subject.

The purpose of this article is rather to discuss the conditions which might result from such action, and the inferences which might be drawn in the case of the earth and other planets, than to make an argument for this theory of upbuilding which may have been more completely stated by others. The appearance of the moon's surface can be studied by any one from photographs, or with a telescope of moderate power, and what is to be seen certainly affords basis for much thought as to conditions which could have created such contours and markings. If we can learn anything by such study it can be inferred that the knowledge has a degree of application to the earth and other planets.

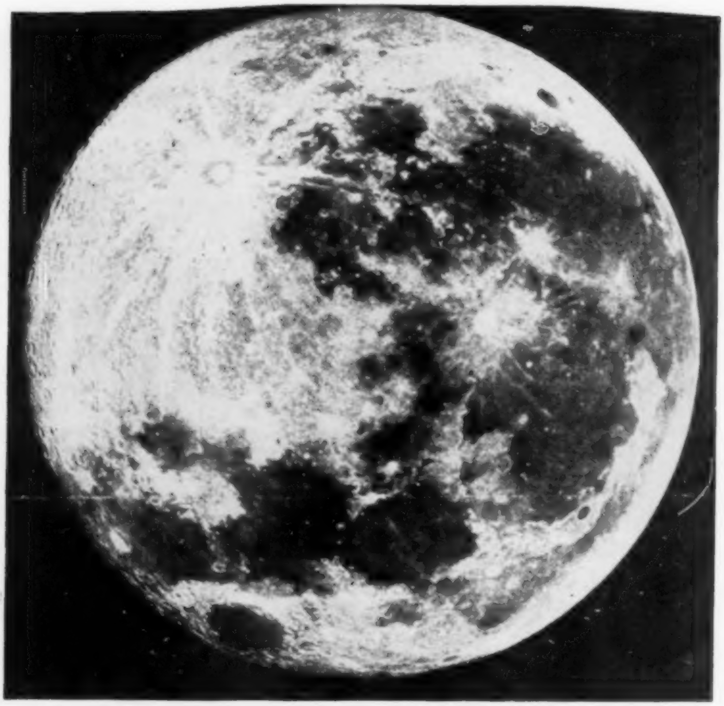
Appearance of the Moon

The surface of the moon is covered with markings, most of which are circular or partly circular in form. The smaller of these markings have been generally spoken of as craters and the roughness of the moon's surface has generally been attributed to volcanic action. The smooth areas of the moon which have been called seas have also been attributed to extrusions of lava from the interior.

Even if we were disposed to believe that a molten moon would in cooling be subject to such vast and widespread volcanic activity, a view very far from that of the writer, there are various conditions which clearly show that many of these markings are not volcanic craters. In some cases two and even three of these circular markings overlap each other and their positions with relation to each other are arbitrary, while terrestrial volcanoes are confined to certain regions or lines of supposed weakness.

If the moon is looked at through a small telescope or a field glass its surface seems to be covered by areas of relatively dark and light color. An examination with a stronger glass of these darker areas will show that they are almost uniformly smooth in surface. Now, if we again use the weak glass and observe the general effect of these darker patches, it will be seen that their shape is either definitely circular or such as would be made up by the overlapping of several circles ranging in sizes from about 200 to 700 miles in diameter. These markings are somewhat confused and the circular form of many of their outlines is more noticeable in a slightly magnified view which does not show all the detail. In such a view the outlines, or partial outlines, of about ten circular areas can be perceived. The surface outside of these smooth areas is much broken and covered by hundreds of such circular pits.

The belief of the writer is that the moon's surface simply shows the record of its upbuilding through the entrance into it by gravity of thousands of bodies of various sizes. If we examine the



THE MOON AS SEEN THROUGH A SMALL TELESCOPE.

THE SURFACE OF THE MOON SHOWING THE PITS, WHOSE ORIGIN IS UNDER DISCUSSION.

moon with this idea in view and with reference to the probable sequence of events its surface shows just what might be expected.

Distribution of Matter in Solar System

The most generally accepted theory of the formation of the solar system is that the sun was at one time disrupted probably through tidal effects produced by some other body passing near to it. Such an occurrence might scatter its material in such a manner as would be necessary to the final upbuilding of the planets. In considering such an event we might imagine that the material would be widely and more or less uniformly distributed in a finely divided state, or that it would be thrown out in masses or in clots which might soon draw together by gravity into masses which might be hot from the original forces of disruption and from the heat of recombination.

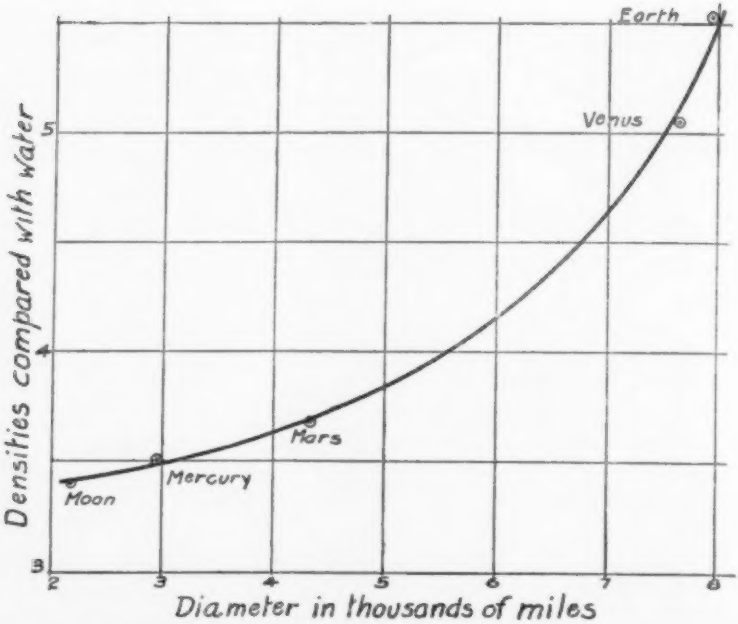
In the opinion of the writer this theory of scattering in masses is not tenable, and it seems much more probable that the material would be widely diffused and quite finely divided. In such an event the acceleration of no two parts would be exactly the same and the strength of material and its adhesion by gravity would be insufficient to hold it together in large masses. That there was not a completely uniform scattering of finely divided matter is evidenced by the fact that the orbits of planets are not circular, while the fact that they are nearly circular and in the average much more circular than those of the minor planets would indicate that the matter was much diffused.

The original motion received by any individual body in such an event could not be such as to give an orbital motion which was nearly circular. A circular orbit could only result from the combination of many bodies with orbits having various degrees of eccentricity. If any mass approaching the size of existing planets had been originally thrown off it would have had a highly eccentric orbital motion and would in a large measure have retained it. Thus the character of the orbits of the solar system may give us some clue to the nature of the upbuilding of the different bodies and the facts seem to give support to the general theory here suggested since the smaller bodies generally have more eccentric orbits. Most of the planetoids have very highly eccentric orbits. The eccentricity of Mercury is twelve times that of the earth and that of Mars five times that of the earth.

The surface of the moon gives an idea as to the early state of such scattered matter and indicates an order of upbuilding which seems quite consistent with the laws of physics.

In the early stages of such a process the space would be filled with many small bodies which would all move in orbits of various degrees of eccentricity. These small bodies would soon be cooled by radiation and would be drawn together by mutual attraction with small forces which would produce little heat when they came together. The larger bodies would capture smaller ones and would at first become overlaid with relatively loose material which would show circular pits where the different bodies had struck. Such a surface is seen on the rougher and more elevated portions of the moon's surface.

As time advanced many bodies in a given orbital zone would be subject to such accidental upbuilding and, as the smaller bodies were so taken up, the collisions would become less frequent, the space being occupied by a relatively small number of large bodies moving in orbits of less eccentricity. These large bodies would still continue to occasionally come together, but very long intervals of time would separate such meetings.



The largest member of the group would ultimately absorb all the others in its zone of action. As its body grew the matter entering it would produce more and more heat.

When the parent body became possibly a thousand or more miles in diameter bodies entering it and much of the material of the parent in region of entrance would be heated to fusion so that the place of entrance would flow to a level smooth surface composed of material presumably denser than the original material for the same reason that solidified lava is generally heavier than crystalline rock. After the formation of such smooth areas there would still be some small bodies free and some of these might be expected to ultimately fall into the smooth areas, making occasional pits in their surface as is seen on the moon. Such pits in the smooth areas show a uniform sharpness of outline and detail which might indicate relatively recent date of formation.

The surface of the moon, as has been stated, shows many such smooth lowlying areas. Some of them are definitely circular in form and others show outlines in part made up of the segments of circles. The moon also shows several prominent ridges which have the form of circular segments with the concave side steep, which presumably at one time formed part of the boundary of such areas of entrance.

There are other interesting features of the moon's surface which bear upon this theory. There are one or two places where spherical bodies have entered smooth areas, presumably before they were cooled to great depths, and have left only a faint circular ridge, and there are places where prominences have apparently partly been absorbed by fusion into molten matter below them. There is also a point on the moon's surface which has been named Tycho from which apparently solid matter has been scattered in definite radial lines as much as a thousand miles long, a phenomenon very difficult of comprehension but suggestive of an impact from without. Other features of the moon which are

significant in connection with this theory are its lack of atmosphere and its low density which will be discussed later.

Relationship of the Moon and Planets

If the moon had been built up in the manner outlined above it might be inferred that the planets had gone through similar conditions and that there should be found in the moon suggestions as to the probable history of our earth which might, or might not, conform to our knowledge of its present condition and past history as read from geological records.

An interesting fact as to the relationship of the planets to each other and to the moon is found in the densities as compared to the diameters of those of which the solid diameter is known. These relations are shown by the curve.

It will be observed that the densities and diameters come in the same order. If these densities are plotted against diameters it will be seen that they fall very close to a simple curve, further suggesting a rule of relation between size and density.

Since these bodies occupy various positions in the solar system, we might infer from this relation that the character of material distributed throughout the system was in the average nearly uniform and that the wide differences in densities of the bodies arose from the greater compression due to increased size, or to changes of material incident to this and the greater heat produced in the formation of the larger bodies.

These conditions can not be a matter of chance. The probabilities of simple conformity in order are 1 to 120, and the fact that these relations nearly conform to a rule of proportion as shown by curve practically excludes the possibility of chance, and by giving virtual proof of a relationship of size and density suggests conditions of matter under compression and heat very different from those with which we are familiar.

Our knowledge through experimentation of the compression of materials can only go to degrees corresponding to depths in the earth of thirty or forty miles, and we can have little knowledge concerning the effects of high temperature under high pressure conditions. Such experimental knowledge as we have of these conditions might not suggest the possibility of such differences as exist, but the fact that certain substances, of which phosphorus is an example, are known to be greatly changed by compression is highly significant in this connection. Great pressure and heat may have unknown relations to matter which may influence radio activity and changes of the elements. Whatever may be all the unknown causes of these differences of density, their conformity in sequence to the sizes is a highly significant and interesting fact, and it tends to give support to such a theory of upbuilding as has been outlined above. It would seem to indicate that the average of material is the same in all the bodies and that the difference is one of compression or some change resultant from heat and compression, both of which are dependent upon size. If the materials of the different bodies were appreciably different, this conformity in order of size and density would probably be interfered with. If separate large masses had been thrown off it might be expected that they came from different depths, or for some other reason might be of different material.

With such relations of condition in view, we might expect that the formation of the different planets was similar in character to that of the moon and that much might be learned concerning the upbuilding of the earth through examination of the many markings which we so clearly see on the face of the moon.

There are, however, very good reasons

why we should not expect to find conditions here on the earth at all like those of the moon. A body falling into the earth in its present condition will generate something like six times as much heat as it would if it fell into the moon, and even in the moon appearances would indicate that the heat was sufficient to fuse the body and much other material about the region of its entrance. The vast heat produced in the case of a body entering the earth would cause temperature conditions which it is difficult for us to imagine and which presumably have wrought great changes in the character of the earth's material, and which also have driven out gases which are now in part represented by its atmosphere and by the water of its oceans.

In the moon the heat of upbuilding being relatively small a vastly less proportion of the matter involved would be discharged as gas and the moon should have little atmosphere and little water on its surface. It should, however, be remembered that the almost complete absence of atmosphere and water on the moon may be more apparent than real. The lunar night being half a month long a very intense cold must develop by radiation soon after the sunset and this cold side of the moon will act as a great condenser to which the moisture will constantly recede from the surfaces heated by the rising sun.

Atmospheres of the Moon and Earth

There seems to be a good deal of uncertainty as to the quantity of atmosphere on the moon. From observations of the refraction or absence of refraction of stars passing behind the moon's edge it has been estimated that it could not be more than one four thousandth of the density of that of the earth. If it had the same quantity of atmosphere in proportion to its weight the ratio of densities would be about 1 to 24.

Pickering has observed various evidences of atmosphere on the moon and some doubt has been raised as to indications of refraction measurements under such conditions. Following the reasoning given above we might expect a very small atmosphere on the moon even if we do not assume that it has gradually lost its atmosphere, as has been thought probable by some students of the subject.

In the present state of the moon, with a night 250 hours long, the light side must be hot and intensely dry and the dark side very cold and presumably covered with snow. Such water as there may be is presumably seldom or never in a liquid state, being either suspended in the atmosphere in a highly expanded state or deposited as snow or frost crystals.

The nature of the action which may have caused the materials of which the earth was built to give up the water of the oceans and the gases of the atmosphere is probably very difficult for us to estimate, since it seems probable that the conditions which brought these changes about are far beyond the scope of our experimental possibilities, but we know that heat can drive quantities of water from various solid and crystalline substances.

If the accumulation of the earth's matter was as suggested above it was originally collected in a relatively cold state, all the small constituent parts having been cooled by radiation previous to their collection. Such loose collection of smaller bodies might involve substances in various forms of combination and capable of great change when subjected to great heat and compression. It is not difficult to account for the production of the water, carbonic acid and oxygen found on the earth since these might have been driven by heat from such materials as we find in the ancient crystalline rocks, but it seems less easy to account for the nitrogen. The only nitrogenous compounds which we know

have presumably drawn their nitrogen from the air. It is, however, reported that nitrogen is discharged from volcanoes and large quantities of it have come from certain deep well borings. It may have been present in the matter of which the earth was formed and have been completely expelled by heat from the rocks which we can observe near the surface of the earth. The relatively little heat generated in the formation of the moon might account for its production in much less quantity there.

Heat generated by Falling

If a body 500 miles in diameter made of such substance, for example, as granite were laid upon the surface of the earth without previous acceleration, its matter would sink into the earth; its parts falling an average distance of 250 miles. The heat generated would be sufficient to raise the temperature of such a quantity of granite about 8,000 deg. F. Such heat, however, would not all be delivered to the falling matter itself. A very large proportion of it would be generated in a large volume of earth material under and around the point of entrance and, since every part of the earth's mass would be moved to some degree, some of the heat would be distributed through the earth's material.

If such a body entered the earth by gravitation through the accident of orbital motion bringing them together the conditions would be very different, since the body would have a high velocity when it came in contact with the earth. This velocity would depend more or less upon the accident of relative motion. The marks on the surface of the moon indicate that the bodies have entered in directions nearly normal to the surface, which would indicate a considerably accelerated velocity, and it might be expected that bodies entering the moon or earth would enter with velocities corresponding to those of falling several thousand miles. If we assume that they have fallen into the moon from distances of 3,000 miles the degrees of heat which should be produced apparently agree approximately with the degree of fusion indicated by the appearance of the moon's surface. In the case of the earth the velocity of entering and the heat produced would be many times greater, but still it is believed that the superficial effect would be local, although other portions of the earth's surface would be much affected by the putting into the atmosphere of vast quantities of steam and gases.

The appearance of the surface of the moon would indicate that few, if any, of the bodies which had entered it exceeded 700 miles in diameter. The largest of the planetoids are thought to be not more than four hundred miles in diameter and it seems reasonable to assume that most or all of the bodies which may have come into our earth during the later ages of its life may not have been very large.

Growth of the Earth

Following such reasoning we would picture to ourselves an earth at one remote time similar in size, density and surface conditions to the present state of the moon. The space near the orbit of this smaller earth would be more or less occupied by bodies of various sizes, all operating in independent orbits with various degrees of eccentricity as in our present belt of planetoids. Each of these smaller bodies would be tending to sweep its orbital space clear of bodies smaller than itself.

From time to time, at longer and longer intervals, the orbits of some of these bodies being influenced by the earth and other planets would lead them into or near to the earth's path, so that the earth's attraction would cause them to fall into it. The relation of motion might be such that, instead of falling in, the smaller body would become a satellite and the satellites of the different

planets may be taken as examples of the unit of material of which the later growth of the planets was made up. The moon is presumably simply a large example of these which once operated as an independent planet and may have joined the earth at a relatively late period of its life. It now always faces the earth as Mercury is believed to face the sun. We might expect that they would both retain some part of the diurnal motion which they should once have had, but they have been situated as at present long enough for tidal forces to stop it, so that they hang in equilibrium like pendulums which have come to rest. Some lack of symmetry in their composition presumably contributes to this, and bodies built as we have imagined might be somewhat unsymmetrical, since the most heated portions might be of different density. Whether an unsymmetrical body would have more tendency to establish equilibrium under such conditions is not established but seems probable.

If we assume such a growth as the appearance of the moon's surface would suggest, we must conclude that later additions to its bulk were probably of diameters as large as from 500 to 700 miles and that their entrances were presumably separated by vast periods of time. During these periods complete stability would be established in the earth and organizations of life would presumably go on. Each of these periods would be terminated by a great change when some new body plunged into the earth's mass. To portions of the world not directly involved the effects of such an occurrence would be largely climatic. The diurnal period and the position of the poles might be slightly changed; great quantities of vapor and CO_2 gas would presumably be put into the atmosphere, geographical changes might greatly affect ocean currents and other conditions which influence climate. Changes of level would flood or drain portions of continental areas. Quantities of solid matter would presumably be thrown out by the effects of extreme heat near the surface but such effects would be local. From larger planets some matter might be thrown out with sufficient velocity to cause it to escape from the parent body and such actions might account for the comets and meteorites which inhabit our solar system, but which have no definite relation to the general plane of its rotary motion.

An interesting fact suggestive of this theory of meteorites is that they are composed largely of iron. The rocks of the earth contain large quantities of iron in chemical combination with other materials and it might be expected that very intense heating would drive off quantities of iron vapor. Since such discharges of metallic iron which were scattered on the earth or in its atmosphere would be rapidly corroded and absorbed by water and later deposited in sedimentary beds we might conceive that such conditions could explain large deposits of iron ore in certain places. Such deposits seem to suggest an origin very different from any present-day rock disintegrations.

It seems highly improbable that any such occurrence could destroy all the life on the earth. It might destroy all of some kinds of life but in most kinds of life, even on the land, there would be remnants which by seeking higher altitudes or other migrations could escape entire destruction.

The region where the new body entered would be completely fused and would fall to a low level and would invariably be covered by the ocean, so that such places can never be subject to our examination. Our continents are the parts of the earth's surface which have not been so hit in the more recent ages of its growth. Their material may be much the same as parts of the moon, except that erosion has removed the sur-

face to great depths and taken away all superficial signs.

Volcanoes and Earthquakes

It has generally been thought that the pits on the moon's surface were volcanic craters and that the moon had been the scene of extreme volcanic activity. The writer's belief is that the moon has never had a true volcano of appreciable size. If we follow the general assumptions as to conditions here outlined we might expect that volcanoes, earthquakes and also gradual changes of level and upheavals of mountain chains would result from the gradual cooling of hot masses of material at and under points where foreign bodies had entered the earth. Such cooling, which, due to the very slow rate of heat conduction, would extend through millions of years, would cause changes of volume and density which would cause gradual readjustments of level.

While the earth in its highly compressed condition shows evidences of great rigidity it is known to yield to relatively small pressures. It has been reported that stakes to which the Eskimo once tied their kyacks can be seen twenty feet below low water mark on the coast of Greenland, indicating that the ice cap a few miles thick is pressing the continent gradually into the sea. It is also known that in our last glacial period the ice caused depression of the region north of the Great Lakes and that it subsequently rose again after the ice had gone.

Such a cooling and shrinkage as is here imagined would presumably tend to cause cracks or lines of pressure release which would result in volcanic action. The interior of the earth is presumably made up of a variety of substances in places much heated, and held together only by pressure. Anything like a crack or vent in such places must result in volcanic discharge.

Theories have been propounded that the earth was once a uniformly heated molten mass which has gradually cooled to form a crust which through shrinkage of the interior is subject to occasional disturbances of the surface. Such a theory to the writer seems wholly untenable and utterly inconsistent with the fact that we have continental, elevated areas and vast depressed and relatively level ocean floors, and that we have volcanic action only in certain regions generally quite near the ocean.

There have been many other theories. One that the moon came out of the Pacific Ocean; another that the continents floated apart on a sea of molten material; another that ocean floors were made by outpourings of molten lava both here and in the moon. All these seem to the writer utterly inconsistent with the facts and with the laws of physics, while the general assumptions made in this paper seem to fit them pretty well.

Geological Record

The writer of this paper can not pretend to enough specific knowledge to form any very definite idea as to how this general theory may agree with the geological and paleontological record. To form a just opinion on such a subject would require much study and a careful separation of existing theory from established fact. Speaking generally it would appear that there is much in these records to support such a theory. It has been said by geologists that the world began its recorded history with a sparse atmosphere and relatively little water, and that it has been through a long succession of mountain elevations and subsequent levelings by erosion, of aridity and extreme precipitation, of tropical heat with a heavy carbon bearing atmosphere and of widespread glaciation. These wide changes from one condition to another have repeated themselves in many cycles from very early times, and descendants of the living creatures of one cycle have generally survived in a more or less changed form in the next.

Professor Lull has described a "Pulse of Life," showing that the evolution of new forms and the disappearance of

older types has generally conformed in time with these great physical changes in the earth and its atmosphere. Such conditions seem to agree pretty well with successive disturbances at very long intervals of time by such causes as have been here assumed.

In the writer's first paper on this subject, which is mentioned above, the idea was suggested that the world at that time, being smaller with a less force of gravity, might have accounted for the great size of some of the large dinosauria and for the fact that jumping was then in vogue among very large creatures, while it is now confined to relatively small ones. The evolution of flight was also mentioned in this paper and it was suggested that a lesser gravity, as well as a denser atmosphere, may have helped it. The evolution of flight under existing conditions seems inconceivable because a creature would require a very highly developed mechanism before the air could appreciably help it to overcome gravity.

If this theory of growth were correct, there would have been a change of size with these changes of condition. Whether such change of size might have been great enough to cause an appreciable change in gravity is a question which we should not attempt to answer without a very careful study of evidences and of the quantities involved.

The interesting fact in this connection is that all the marvelous changes in evolution have evidently been associated with very radical changes of condition. For such changes this theory of upbuilding alone seems to afford adequate explanation. What else could cause a symmetrically cooling earth to change from conditions of relative sterility with periods of glaciation to such a condition as is shown in the coal measures, and later to change back again to such conditions as are known in recent time? What could have produced the level and apparently homogeneous condition of the ocean beds and the smooth level areas on the moon which have been called oceans?

It would appear that all such phenomena might result from collisions of the earth with bodies of such size as are indicated by the markings on the face of the moon, or such as are known to now exist in the belt of planetoids and in the satellites of the various planets.

It must be borne in mind that the continental land bodies of the earth are by this theory the parts which have not been entered by bodies in relatively recent times. Otherwise they would not be continents but would be covered by the ocean. We should expect, however, that in very remote times these also have been hit by smaller bodies with less velocity and, although great quantities of material have been eroded from all surfaces, we might expect to find large areas in which the rock was of a newer and different character and that some of these areas might be found to be of a generally circular form.

The shape of ocean bed areas on the earth do not seem to indicate, as in the case of the moon, that they might have been formed by the entrance of spheres, but the covering of water would naturally greatly change the outlines, and a greater gravity with less degrees of elevation would make such markings less apparent.

There is one geographical feature on the earth which might suggest an origin similar to that of the partially circular ridges on the moon—that is the fact that the Aleutian Islands are arranged in an almost perfect circular arc—a strange fact, since nothing of the nature of a circle exists elsewhere in natural objects except for a definite reason. An investigation of conditions in that region might establish a relation between this fact and the theory stated in this paper.

The ideas and opinions here stated are not given as established truth but simply as suggestions as to reasons and relations which might justify careful study and comparison.

THE DETERMINATION OF SEX

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SEX, its various phenomena and particularly the possibility of its control or determination, has intrigued the human race apparently since the beginning of thought. Religions have been based upon it and innumerable attempts have been made to explain the why and wherefore of male and femaleness as well as to influence the proportion of the two sexes. There are now said to be over five hundred theories of sex determination, all of which have been additions to the hypothesis proposed by Drelincourt in the eighteenth century and put forth together with a review of what he termed two hundred and sixty-two "groundless hypotheses." As a subsequent writer pointed out, nothing was more certain than that Drelincourt's idea formed the two hundredth and sixty-third. So on down to the present day, man, able to control so many features of life, has constantly attempted to get at the basis of the fundamental phenomena of sex. As there are but two sexes the laws of chance will operate in favor of any theory 50 per cent. of the time and great things have been heralded by the proposers of various explanations deduced from isolated or selected instances.

In general two methods have been used in the more recent studies of the basis of sex differentiation, one being an analysis of the functional or physiological problems involved, the other being a study of the structural or morphological characteristics associated with sex. Under the first heading may be grouped all the experiments dealing with castration, with the secretion of the sex glands and their effects on other tissues, the chemistry of the sex cells and with the various attempts to regulate sex ratios. The morphologists concern themselves with studies of the microscopic anatomy of the two sexes and with experimental breeding. It is perhaps unfortunate that the members of one group have, as a rule, relatively little first-hand knowledge of the results obtained by those in the other field and *vice versa* with the consequent retardation of the achievement of the final solution. Although I may be open to a criticism of personal bias, it may be claimed that the morphologists in the past have perhaps erred less in this respect than have the physiologists. Happily the two groups are now finding their mutual information useful and are drawing more closely together.

Of the various physiological studies on sex that have been carried on those of Whitman and Riddle on pigeons are of outstanding interest. Sex, according to them, is a function of the metabolism of the egg; eggs with a comparatively high rate of metabolism develop into males, while females result from eggs of lower developmental energy. These modern observations are strikingly similar to the not uncommon conception of males being the product of a "strong" germ and the opposite sex arising from a "weaker" one. The physical and chemical condition of the egg seems to be a factor in the determination of sex, for maleness seems invariably to be associated with a high percentage of water and a rather low percentage of fat and phosphatides. The opposite conditions

are found in female-producing eggs. These results get considerable support from the studies of other workers on frogs and toads where it was found that (for frogs) when the eggs were overripe and a large amount of water had been absorbed by the egg before fertilization practically 100 per cent. males resulted, while the withdrawal of water from the eggs of toads before fertilization had occurred produces about 90 per cent. of females. Riddle has been able, by altering the physical conditions according to the observations outlined above, to reverse the sex of the egg and consequently that of the animal which would arise from it, which is an exceedingly impressive demonstration of the working out of his theories. Before, however, we further consider the more or less purely physiological account of sex determination let us see something of the morphologists' side of the story.

During the last thirty years an enormous amount of data has accumulated that indicates practically beyond question that the sex of the future animal is decided at the time the two germ cells unite. This is brought about by all the germ cells produced by one sex being alike, while those produced by the opposite sex are of two classes—male and female determining. When a male-determining cell unites with the neutral gamete of the other sex a male develops and *vice versa.* Sometimes it is the female that is monogametic (that is, produces but one type of germ cells) and again it is the male. The former case is, as far as known, much more common than the latter. Man, as an example, produces two kinds of sperm and but one kind of egg, while in birds the reverse is true, the female producing two kinds of eggs and the male only one type of sperm. Both the microscopical and the breeding evidence demonstrates this convincingly.

As the only connection between parents and offspring consists of the microscopic germ cells obviously all hereditary possibilities must be carried by them. In these cells are minute bodies known as chromosomes, which because they are the only obvious material in the germ cells that is contributed in equal quantities by both parents and because of the extraordinarily accurate mechanism that exists for its exact division and distribution to all the cells of the body, are believed to be the carriers of the hereditary characters. Some of the interesting features of the chromosomes are their constancy of number in a given species of plant or animal, and their constancy of shape, which, small though they are, makes the recognition of individual chromosomes within a species readily possible. Since sexually produced animals are the results of the union of two cells contributed by the father and the mother the chromosome contribution from each parent must theoretically be and actually is the same. Each parent has passed on half of the chromosomes found in the offspring and each one of these bodies that came from one parent has been shown, with the possible exception of the chromosome associated with sex, to have a counterpart or mate in the series of chromosomes that have come from the other parent. So all the chromosomes of the cell, like the fabled animals of the Ark, go in two by two. As constancy of chromosome number is a characteristic of species there must be some mechanism to control the number or else it would tend to double at each generation. This mechanism is found in the development of the germ cells where, before they become mature, the number of chromosomes is reduced to one half. Consequently, when egg and sperm, each possessing half the usual number of chromosomes, unite the entire number typical of the species results.

A most important clue to the importance of chromosomes was brought out

in the discovery in 1902 by Dr. C. E. McClung that male grasshoppers, during the period of the reduction of the chromosome number, produced two kinds of spermatozoa, one of which had one more chromosome than the other. Since these classes of sperm were produced in equal numbers it suggested some relation to sex and subsequent work substantiated the hypothesis. The females were found to produce only one kind of egg, all of which contained the same number of chromosomes. When the spermatozoon possessing the extra chromosome united with an egg the combination resulted in a female as the typical chromosome makeup of a female was produced. When, on the other hand, one of the second class of sperm, which lacked the extra body, mated with an egg a male was the outcome, as the chromosomal conditions associated with maleness were restored. In this particular instance the total number of chromosomes of the female was one more than that of the male.

The differentiation of the male and female determining germ cells occurs during their development or maturation. At this time the sex chromosome which, unlike the other chromosomes of the cell, is frequently without a mate, passes bodily into one of the daughter cells during one of the divisions that takes place in this process, leaving the other cell without a sex chromosome but containing all the others. The reduction of the chromosome number during germ cell development may be illustrated somewhat as follows:

A—the maternal and paternal chromosomes other than the one associated with sex.
X—the sex chromosome which is paired like the other chromosomes in the female but is single in the male.
O—the absence of a sex chromosome or of the mate of the sex chromosome in the male.

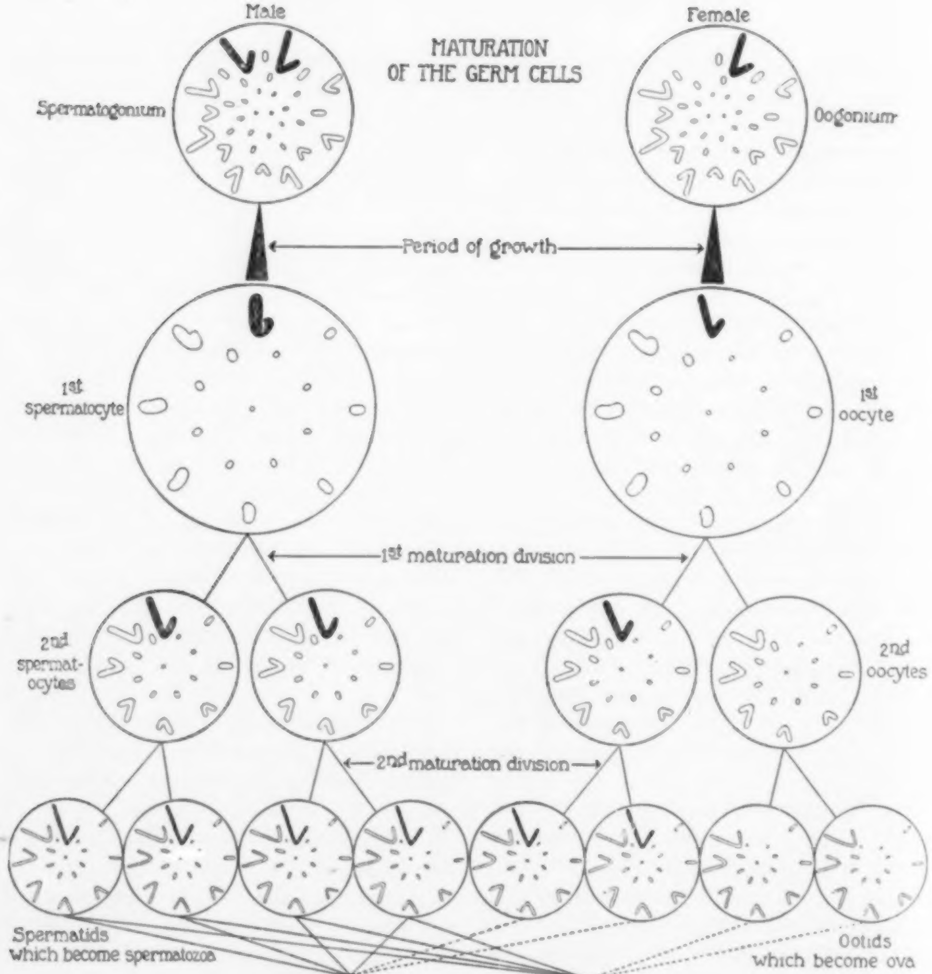
Full number of female chromosomes		Full number of male chromosomes
AA XX		AA XO
Reduced chromosome number of female-mature egg.	A X — No. 1 — A X A X — No. 2 — A O	Reduced chromosome number of male-mature sperm.

Union No. 1 produces—AA XX—female.
Union No. 2 produces—AA X0—male.

Femaleness is, in this example, associated with the cells of the animal containing two "X" or sex-chromosomes and maleness with but one. The morphological behavior of these so-called sex chromosomes has been found in complete accord with the mode of inheritance of such sex-linked characteristics as color blindness. This abnormality tends to be associated almost wholly with the male sex and to be transmitted through the daughters, who fail to show it, to their sons.

A similar situation regarding sex determination has been found in other animals, including man, *i.e.*, an odd chromosome associated with maleness and a pair of chromosomes with femaleness. In a few cases, although the principle is the same, the mechanism is reversed and it is the female that produces two kinds of eggs and the male but one type of sperm. The discovery of such cases has given very material support to the chromosome hypothesis of sex determination. The domestic fowl is the most recently studied form that falls into this class, and it has been found that in these birds the female has only one of a certain chromosome while the male has two. This results in two kinds of eggs and one type of sperm or just the opposite to the condition found in man and other forms.

The above account has sketchily outlined two broad fields of investigation on sex determination, the results of which



TEST-FIGURE 1. (Taken with slight modification from the *Journal of Morphology*.) A diagrammatic representation of the chromosomes of the domestic fowl in relation to the two sexes and to their behavior during the development or maturing of the germ cells. The small figures within the circles represent the chromosomes and those drawn in solid black are the ones considered to be associated with or directly instrumental in the determination of sex. The "cells" at the top of the diagram contain the chromosomes in full number as found in all the cells of the body and in the immature reproductive cells. Before they become functional as germ cells the chromosome number must be reduced to half as described in the text. It can be seen that, of the mature germ cells, the male cells or spermatids are all alike in possessing one black or sex chromosome while in the case of the female cells half have the black chromosome and the other half lack it. The possibilities of union are illustrated by the connecting lines. This diagram would fit the conditions known to exist in humans if the column of cells called "Male" be labeled "Female" and *vice versa*. In either case the principle is identical.

to date would seem quite antagonistic and are indeed so claimed by some. In the one case we find sex apparently controlled by certain obvious physical and chemical characteristics and in the other by a microscopic anatomical mechanism, the chromosome, whose behavior is so marvelously constant and which fits in so perfectly with genetic data. Which, if either, is right?

Certainly the evidence for the chromosome hypothesis, impressive though it is through furnishing a basis on which genetic results may be predicted, is still presumptive and is lacking in a genuine demonstration of the potency of these minute bodies. This possibly is less distressing to those who are best informed about the physical behavior of chromosomes than it is to the opponents of the theory. It has frequently seemed to the writer that these opponents have usually failed to recognize the fact that while the chromosome students must necessarily refer to the objects of their consideration as definite and visible entities, they have never lost sight of the fact that the chromosomes can not possibly act as units but only through the chemical possibilities they carry or even, from an extreme point of view, are the result of. While the evidence is strong for the maintenance of their individuality and constancy it is not unreasonable that a change in environment might cause a reaction in the chromosomes that would make itself obvious in hereditary alterations. It would be a brave cytologist who, with our present knowledge in mind, could think otherwise. Since the cytologists, because of their lack of any real knowledge of the subject, have generally neglected to stress their conceptions of the physiological behavior of the chromosomes, the physiologists have tended to underrate their probable importance. On the other hand, such work as Riddle's, carefully done and extensive as it is, will be the more satisfactory when the other side of the story of his pigeons—the chromosomes—is known.

Of interest in this respect are Dr. Riddle's[1] own views of the hypothetical place of the chromosomes in sex determination:

> The basic fact is that the two kinds of germs are differentiated by the degree or level of their metabolism. When either of these two kinds of germs is forced experimentally into the production of the opposite sex, the level of its metabolism is shifted to the level characteristic of the germs of the opposite sex. While the chromosomal correlation is here forced to failure the metabolic correlation here persists. The chromosomal constitution is not an efficient cause of sex; it is but a sign or index and possibly an assistance in the *normal* maintenance of that which is essential—namely, two different metabolic levels. But the requisite metabolic level of the germ may be established in the absence of the usual or appropriate chromosome complex, and the sex of the offspring made to correspond to the acquired grade or level of metabolism.

Doncaster[2] expresses the morphologists' beliefs in a way that differs from the above possibly only in the slightly greater importance assigned the chromosomes:

> The general conclusion would thus be that sex is dependent on a physiological condition of the organism, a condition depending on the interaction of certain chromosomes with the protoplasm of the cells, and therefore determined, in the absence of other disturbing factors, by the presence or absence of these particular chromosomes. If the difference between the chromosomes of the male and female is considerable, it will outweigh any other influences which might tend to affect the general result; every cell of the body will have either the male or female condition, and no external agency will be able to affect either

[1] Riddle, O. 1917. "The Theory of Sex as stated in Terms of Results of Studies on Pigeons," SCIENCE, XLVI, 19.

[2] Doncaster, L. 1914. "The Determination of Sex," Cambridge University Press, p. 144.

[3] Lipschütz, A. 1924. "The Internal Secretions of the Sex Glands." Williams and Wilkins Co., Baltimore.

the sex or the secondary sexual characters. This condition is especially characteristic of the Insects. When the difference between the chromosomes of the two sexes is less, but still sufficient to outweigh the effects of most environmental changes, the difference will usually be sufficient to turn the scale decisively to one sex or the other, but the secondary sexual characters will be less dependent on inherent differences in the tissues of the animals, and more on the influences exerted by the secretions of the sexual organs. This is the condition found in Birds and perhaps less markedly in Mammals. Finally, when the chromosome-differences between the sexes are still smaller, they will only be able by themselves to determine sex when no other causes influence the chromosome-protoplasm relation; if this relation is affected by other agencies, it becomes possible for an egg which would otherwise have been a female to develop into a male. This nearly evenly balanced condition is best known in the Amphibia, but there are indications that it is approached by some mammals.

We have reviewed the current opinions of the determination and control of the most important organic attribute—sex. One group of workers believe that maleness and femaleness are the result of the physiological condition of the egg, while the other group finds the sexes to be constantly associated with particular minute intercellular bodies, the chromosomes. The latter group agree that these particular chromosomes are concerned in some way with the physiology peculiar to the sex they are associated with, while the former believe that the physiology of the egg may at times counteract or in some way influence the function of the chromosomes. To the writer the chromosome hypothesis seems to be a bit better established, although the final conclusions may very well include the essential facts from both fields of investigation. In any case we find ourselves in the year 1926 still accepting the decisions of nature in regard to current sex ratios.

THE PASSING OF THE PROFESSOR

By DEAN OTTO HELLER

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From the conning tower of eminent seniority I lately reconnoitered the academic field for the remains of that demolished institution, the college. Its site was marked by a disintegrating structure inclosed by a mixed assortment of decidedly new-looking buildings, composing a "general store" of knowledge called a university. The emporium teemed with young people, but most of them roamed about the premises like mere "window shoppers." In place of the old attachés one noticed a scurrying sales-force gowned uniformly in black brightened with the emblems of the various departments.

I concluded that the old professor had perished together with the old college. He passed out without pompous funeral, without necrologues, with hardly an obituary notice. I suspect an excess of absurd though not unkindly cartooning hastened his end. In self-defense against a world in flux he conformed himself to his caricature and became a fossil—which under dictionary definition means "an organic body so situated in its surroundings as to be capable of indefinite preservation." It availed him not. If the drop hollows the stone, how can a petrefact keep itself afloat on the deluge?

I

The modern college professor seems altered from the old pattern by something more radical than the imperceptible workings of evolution. He is apparently of quite a different make, normal and homogeneous in appearance and wholly devoid of that touch of freakishness which, after all, was an index of personality. Full regalia seem but to advertise him as a "quantity product" and do not cover up his family resemblance to those prouder cousins who do business on the Rialto. This explains the ardent admiration conceived by the Reverend William Sunday for the species. When, for his countless battles for the Lord and victories over Satan, that whirling Christian dervish was created a doctor of divinity by the University of Pennsylvania, he took one look at the galaxy of magnificoes and then, dropping on his knees, gave heartfelt praise to their Maker: "O Jesus, what a wonderful bunch of men!"

Go at the noon hour to the pastures of the Elks, the Moose, the Buffaloes, the Bulls and the Bears, and I defy you to spot the sporadic professor among his Loyal, Benevolent and Protective Brethren. Formerly he was alien to their lairs, now he is hail fellow well met there. They did not use to invite the "highbrow" in, for they felt uncomfortable in the company of literary aspirations. Nowadays, the bookish interests of the collegian run much the same way as theirs: to the volume of business. He frequently lectures to them—on the psychology of salesmanship, by preference, or gives inspirational talks, perchance on Christ as a Rotarian, or on the human side of retailing.

The townsman no longer shrinks from the encounter with the gownsman's portentous erudition. Pedantry is the least of the current professor's failings. He behaves quite like a plain citizen and can talk glibly on topics dear to Kiwanian hearts: the sporting page, the last quotations, the radio news, the golf

score, the *Saturday Evening Post*. He has even learned to desist habitually from that fastidious use of the mother tongue singled out by President Eliot as the unmistakable mark of the educated. Bad English comes as natural to him as to Mr. Theodore Dreiser, so that one is driven to repudiate the charge that this lack of refinement is merely assumed for protective coloration. Nor are the conversational tastes essentially different within the privacy of the set. Such things as literature, philosophy, art, science, music, the theater, are seldom seriously discussed save in pragmatical relations. Questions of a merely general connection, such as moral, philosophic, esthetic issues, are rarely aired among us. Unyielding controversy used to be carried on, in and out of our meetings, concerning educational matters of all sorts, broadly human as well as technical. Now we rarely grapple with the more fundamental problems. The agenda of our conventicles gravitate about dreary points of routine; deeper educational aspirations and anxieties are a private concern and as a rule remain a personal secret. The professor, singly, meets the most parlous moves—such as the fanatics' attempt on the life of science, or the boor war against the humanities—with the fortitude of bland indifference. Hence in the aggregate he becomes a silent and dangerous partner in the business of uneducation: master of the arts of acquiescence and doctor of the philosophy of *laissez-faire*. Or do we ever put up a counter-offensive against the impudence of the enemy, ever raise our voices in concert in behalf of good taste and civilized thinking? I ask, do we do that even under the stinging provocations of the Babbitts and the Bryans? The natural guess in reply to rhetorical questions like these is that in these times the college teacher himself may not be a developed specimen of cultured humanity. Environment and circumstances have made his mind business-like, matter-of-fact and almost closed to esthetic influences, while enthusiastically open to buncombe and balderdash.

The old-time professor was often categorically denounced on the outside as an "academic snob," not because he gave himself airs, but simply because he did not pretend to think and feel like a green-grocer or a manufacturer of chewing gum. To-day, a man afflicted with "aristocratic" proclivities does not have to step off the campus for his cure. We strive to please the crowd and capture its benevolence by imitation. Soon we become like our models.

The modern professor condones uncouthness in the undergraduate because he himself is ordinarily deficient in social graces and beset with angularity and crudeness. He cares nothing for deferential consideration from his students, because, it must be remembered, he was not drawn into the profession by any anticipation of social delights. Himself a product of the "new education," he can join in the popular rebellion against refinement without a sting of apostasy. Dignity demands reserve, and reserve goes with privacy; the live-wire professor has neither. He works amid bustle, and his spirit is in full rime with his environment. A barrage of typewriters, adding machines, card catalogues, filing cases and kindred paraphernalia of the educational industry does not protect him from constant trivial intrusion. Vendors of every time-payment commodity from encyclopedias to carpet sweepers and from canned music to group insurance stream unchecked into his sanctum and render his intellectual effort intermittent and desultory.

The rapid infiltration of business ideals has produced in our circles a new set of ambitions. As those conversant with the ways of the world academic know, a professor's standing in official favor, and his chances of advancement, are greatly promoted by his footing in

the community. Especially in urban universities the ideal "campus man" is likely to lose place to the better "mixer." The outside popularity of professors has great weight on the salary scale, and at some seats of learning its evidences are scrupulously booked and tabulated. While in earlier days a scholar was apt to be judged, not always wisely, by how much he published, he is now reversely appraised by the publicity he draws to himself. Last year the prize man of a certain faculty bagged thirty thousand agate lines from rural newspapers, largely as the result of indefatigable speech-making at Grangers' meetings and Teachers' Institutes. On the strength of this phenomenal "service" his salary was raised $250 at a single stroke.

These hectic activities do not alter the painful fact that the professorial chair as such functions as an insulator so far as important contacts go. Its occupant is compelled to channel his influence by indirection, through alien media. He is no longer a civic agent in the chemical, but only in the commercial, acceptation. As such, he has naturalized the vocabulary of high pressure salesmanship in his trade territory. The professor wants to make good, show results, sell his subject, deliver the goods. He joins lustily in the sloppiest slogans of commercialism and repudiates all claim to superiority over the hawkers of other wares; the more loudly he informs them that they are as good as he, the more they believe themselves very much better and treat him with marked condescension.

Far from mourning over the departure of his prestige, the professor hails it as a happy omen, for it betokens to his prophetic soul the "rising tide of democracy" and heralds the advent of the universal brotherhood of man. Now and then, to be sure, the brethren in the other walks inflict a chill on his *amour propre*. Instance a couple of recent experiences of my own. In our quad of a Sunday a gang of plasterers were breaking the Sabbath — quite gently, you may be sure—to the edifying ring of three dollars an hour. Maybe by the cut of my jib or, more likely, by the cut of my clothes, one of them guessed my humble station, and, seizing on me as pretext for an intermission, asked some questions about the business I am in. I told him among other things that the average college teacher needs a dozen years to fit himself for a job, and that for a similar period he "pulls down" less than fifty dollars a week. "This gets my goat," he condoled; "you fellers must be nuts."

And this I was told while on the road, incognito: "Take it from me, sir, everybody who's got any brains at all is after the almighty dollar—except them scholars and professors, I s'pose. But we've got over all that—there's nothing to it." It is consoling, after all, to be classed with the semi-intelligent, when one of our own order, writing last month in *The Nation*, declares us to be minus brains—and faith and courage to boot.

Now and then I meet some one who has "outgrown teaching," as he puts it with pardonable pride. Usually he is the holder of a high executive position, either in the scholastic industry, or in some more frankly utilitarian business. Invariably these converts, whether engineering some big educational establishment, or efficienceering a dry goods concern, consider the change a promotion. One of my former colleagues was thus beguiled by the voice of the charmer: "Come on, Prof. You're too smart for education. Take this job, and make a man of yourself." The "Prof" came on.

Thus, in sharply separated layers of society, little value is attached to the professor and his occupation. Even in the universities themselves those charged with administrative duties hold the favored places at the academic spread,

while the plain professor, the mere man of learning, sits below the salt, meekly playing his knife and fork without much friendly encouragement from those higher up.

II

For a moment let us dip into intramural sociology. As concerns the regents, or trustees, they are as a rule persons of great eminence in the business world, with hardly a bowing acquaintance with the corps of instruction. As they belong by virtue of their circumstances to a sphere that barely glances the academic orbit, there can be nothing invidious in their aloofness.

Heroically supersized in the community's vision, they hover abstractly above the stage of action, thickening into human shape on certain public occasions, but never getting down from the serene height of their *theologeion*. Sometimes they take an active interest in the financial welfare of the institution under their control. To the personnel they do not have to devote much care, if any at all. In privately endowed schools they are usually selected for their ability to contribute liberally to the funds. In many cases they justify the speculation beyond the dreams of avarice; sometimes, though, they do not come across handsomely, and enjoy the honor without giving any return. From the degrading influence of the lowbrow politician at any rate this class of institution is almost entirely free. In state universities and "land grant" colleges, the regents are appointed mainly for political reasons and occasionally given to crude persistence that the university shall give the taxpayer what he wants.

The recent enormous aggrandizement of the college president, as evidenced, for example, by his pompous installation in office, I do not presume to explain. Not so long ago, the president sat, so to speak, on the same platform with the faculty, and his superiority was secured chiefly by spontaneous respect for his stature. To-day the president is not necessarily the biggest man in point of insight and inspiration. Consequently, the distance between the academic body and its head has been stretched in some artificial fashion to give him a semblance of majesty. This could not be accomplished without pushing his authority also to the peak, until his word is law within his domain and well-nigh gospel without. Layman and collegian alike magnify him until he accepts himself at the fantastic value suggested by their homage. Is there any wonder, then, that this adulation has tended to make him arbitrary and dictatorial? At first, indeed, the apotheosis of the president completely turned the heads of some newcomers to the office. *Delirant reges plectuntur Achivi.* A sudden reign of terror threatened to decimate the professorial ranks, and no lives were safe as duodecimo Mussolinis, like the rough-and-ready Benton of Vermont and Ayers of Cincinnati, laid ferociously about them to infuse new life into their schools by a massacre of the teachers. But the treat-'em-rough method of university administration so reduced the attractiveness of the profession that, almost literally, the supply threatened to run out. That was twenty, thirty years ago. The executive attitude that now obtains wisely takes the shortage of man-power into account; consequently, under the newer dispensation the professor is secure enough in his tenure so long as he pulls his load in bridle-wise fashion and does not kick over the traces. In the American university of to-day acceptance of the régime comes before loyalty to the institution and to the cause of learning. Open criticism of the president is lèse majesté and mutiny. There is of course very little of that, and the average professor holds back with any opinions that

might antagonize the "administration." It is a humiliating comment on the energy and initiative of our faculties that with us changes in education, beneficial or otherwise, are largely the work of determined presidents, whereas throughout Europe they are inaugurated by the teaching force. A *ben trovato* incident epitomizes the difference. During his term as rector of Berlin University, the great theologian, Adolf Harnack, is said to have presented President Wheeler, of the University of California, to the German Emperor with this speech: "Will Your Majesty graciously receive our distinguished guest from the United States. He fitly bears the title of 'Exchange Professor,' since he comes from a monarchy within a republic to a republic within a monarchy." That this monarchic form of government moreover leans heavily toward absolutism is chiefly the fault of the governed. The disunion of the teaching force, its lack of parliamentary sense and its disposition to let issues be swamped by details and causes by personal animosities, make a return to republican governance undesirable while the professor's nature remains as it is. It almost looks as if a much greater centralization of authority might be needful to save the "higher" education —which just now justifies its name by being all up in the air. The titular address of a university president abroad is "Your Magnificence." In this country we may yet come to address him as "Your Omnipotence," without further detriment to the cause of education.

The university president's compulsory intercourse with wealth and power inescapably affects his mode of living and, under Veblen's theory of the "Leisure Class," involves him in pecuniary emulation. In the halcyon days of the McCoshs, Gilmans and Eliots this tendency was inchoate, and the presidential ménage was not markedly different from the professorial. They held to the same standards of dignified and by no means inelegant simplicity. Therefore the president was seldom paid even twice the regular professor's salary. Owing to the high cost of social importance to-day the disparity of the two types of pay is so great as to place the president and the professor on opposite economic and social footings; the one is merged in the mass, while the other dwells apart in regal grandeur.

I am not making a special point here of the professor's notorious impecuniosity. On the whole, he is better off, not worse, than was his predecessor. And in announcing the latter's demise, I did not blame his death on starvation. He was neither gourmand, nor gourmet, and all his tastes were frugal. In his raiment he was averse to splendor, if not always to shine. Yet he was not without his comforts and special luxuries. He indulged in a good concert now and then and in a high-class play, in course of time accumulated a fine collection of books and once in a while contrived a trip to Europe. The luxuries of conspicuous living which were beyond his reach he happened not to covet. So he got along on very little, yet maintained a high degree of social dignity in all relations. Far from grouching over his lot and his labors, he considered himself generously compensated by his position of honor in the minds of the people. True, he may have reasoned himself into this happy peace of mind by such romantic arguments as brightened Bishop F. D. Leete's pastoral message to a recent Methodist Conference: "The time has come"—quoting the right reverend gentleman literally—"when ministers are paid as well as the average layman, for their pay includes opportunity for intellectual improvement, possibilities for desirable friendship with God, and the gratifications that come to those who render spiritual aid." Or he may have remembered Plato's more original prescript for the

elect: "As for gold and silver, we must tell them that they are in perpetual possession of a divine species of the precious metals placed in their souls by the gods themselves and therefore have no need of the earthly one." Anyway, the peace of mind was there and in conjunction with the professor's temperate habits conduced to such a lengthening of life that in the eyes of Messrs. Andrew Carnegie and Henry S. Pritchett professorial longevity presented a grave educational problem. For which reason they persuaded Alma Mater to wean that overgrown child from her breast before a possible lapse into second infancy, and for the sequel relied on the lethiferous effect of unemployment doles. The well-hecked scheme foundered on the pensioner's tenacity of life and his ability to subsist on hopes, ideals and kindred inedibles. Progressively the rations were attenuated, to no avail. The trimming down of the Carnegie stipends appears to have been a standing order of business and possibly something of a standing joke, too, between the Laird of Skibo and his Grand Almoner, for the more the pension was enlarged upon in reports and circulars, the smaller it became. And still the old prof stubbornly held on and refused to pay his debt to nature. In sheer despair at being unable to kill him off, they lastly killed his pension. Even after that he stuck it out a little longer. And never a complaint did he utter. "The Laird giveth, and the Laird taketh away. Blessed be the name of the Laird." Dear old soul!

The lesson of it is, you may separate a professor from his provender, but you can't starve him to death. And so he has to be led to heaven through another gate. The experiment under way is that of working him, or making him work himself, to death. He willingly submitted to the experiment, after swallowing the superstitious story about the American business man working fifty weeks in the year, six days in the week, and eight hours in the day, and taking with alacrity the hint that it was incumbent on the American scholar to behave like the American business man. In theory the "teaching load" in the colleges has not been increased, but in actual practice a professor, if his lines be cast in the academic hinterland, almost doubles his schedule in supplementing his revenue by teaching in summer schools, Saturday schools, night schools, correspondence schools, thus acting as gun-bearer to the devil in his devastating pursuit of scholarship. In very many cases a university teacher in the professional branches adds permanent or casual outside jobs to his scholastic duties. Yet it must be said in his favor that none of his multifarious tasks are taken lightly, and that he is held by his inherited conscience to a generous discharge of all his duties. How soon under such a burden he will wear himself out is still an experimental question. In the meantime, sixty-five is the official *nec plus ultra* for the professor, while no statute of limitation is set upon the service age of trustees. Perhaps their reserve store of vitamins is deemed a guarantee against senility. Or is, perchance, no brainwork required of them?

Out in one of the Ohio road colleges the trustees perpetrated a grim joke on themselves, by account of a recent novel. The ablest man of the teaching force, having reached the retiring age while still in perfect physical and mental condition and being greatly in need of the income, petitioned for a prolongation of tenure. No, sir, said the trustees. We are sorry for you, but you are too old to teach. Your mind has lost edge for any real intellectual exertion. However, in recognition of your past usefulness to our beloved institution and to retain you in her service, we have elected you a life member of this board.

I repeat that I can not regard the salary question as the crux of the profes-

sor's social predicament. True enough, he did find himself in a sad economic plight during the war and right after. But since then a nation-wide support of his demand has borne fruit so that, under a bettered wage scale, he may brave the responsibilities of marriage in his middle forties and in his fifties may even contemplate paternity. Yet for the needs of dignified family life our salaries are still far from adequate. I am unwilling to concede that a competent university teacher should travel through life with a lighter purse than a public official of corresponding accomplishment—say a circuit judge; their salaries ought to be equalized, that is, after the judge gets "boosted" to $10,000. In truth, the $10,000 professor is already on his way to school, and in a few places he has actually arrived. Those men are properly paid because they are, or are supposed to be, objects of competition between school and industry or between rival schools, or to have a choice between professing and practicing their knowledge. At all events, these few have raised the standards for their class in several important ways. Impoverished, labor-driven and humiliated educators can not function to much effect as factors of public enlightenment.

III

I am far from arguing that our confrèrie is to be charged with civic indolence. We work rather overtime for the public good. The professor is a fast and zealous "joiner." He pays his full dues in time and money to social, scientific and philanthropic organizations, hobnobs with the politicians and belongs to most of the up-and-doing blatherbunds. In these connections he generously does his chores, but contributes sparingly of his ideas. He knows that the true purpose of higher education is esoteric and can not be openly avowed in a democracy. It consists in steering the gifted minority from the crowd. The up-to-date educator, however, follows on the heels of the crowd, and instead of heading the people for the light, he only quickens their step in their set direction. He has made himself less and less distinct from the crowd and in the end achieved a total lack of distinction.

The painful fact is that in making himself safe for democracy, he has slid down from the upper stratum of society almost to the bottom of the middle class. One commencement orator this year, descanting on the marvelous equality of all Americans in respect of opportunity, naïvely hinted the depth of this fall. Anybody, said he, may become president, "from the highest magnate to the pariah, from the cabinet officer to the college professor." The professor's station in society may seem in itself a matter of indifference, yet there was public as well as personal benefit in the prestige that was his. It brought home to him a gratifying sense of the value of his work. And it was the fountain-head of his influence.

Without demonstrating at further length the social decline of the professorial class, I am prepared to venture a guess that there is no strong desire for change in our *ensemble*. It may seem singular that it should have been reserved for a college president to put his finger with precision on the sore point: "Until class consciousness extends throughout the teaching body," says Dr. McCracken, of Vassar, "the democracy of control will hardly include the professor." Now class consciousness in the last analysis is a feeling of pride in the superiority of one's group to other groups. It is not enough to consider ourselves no worse than other people, we must again learn to consider ourselves better than most of them. "So long as we are no better," says Professor H. R. Mussey in an article of recent issue, "so long the colleges will be no better than the schools and the churches and the trade unions and the women's clubs and

the athletic associations and the chambers of commerce and the sons of deceased patriots and the loyal orders of associated tombstone manufacturers that make up our everyday America."

IV

Now the economic discomfort, loss of caste and shrinkage in self-respect under which our profession labors may plausibly be referred to one and the same cause, namely, to the ominous public indifference toward the so-called higher education. Again it is possible to validate this opinion by means of presidential testimony. Within a half year or so, I have heard no less than three of our leading college presidents avow almost publicly their belief that the American folk do not really love education and are not really a culture-loving people. It would be a miracle indeed if a public that looks for spiritual ministrations to a Billy Sunday and a W. J. Bryan could be seriously interested in the selective breeding of intellects which, when all is said and done, is the chief office of higher education. A higher education ordered by middling-to-low intelligences remains forever a contradiction in terms. Its control can not be committed to the general suffrage, it belongs by right of reason to the enlightened elect. The presupposition upon which the life of the university is founded is reverence for scholarship, irrespective of its utility and popular appeal, and a voluntary subordination of the average mind to a superior grade of mentality. The reverse relation is responsible for our shallow national percipience. Only through soul-searing abatements from hallowed conviction and sacrifice of principles could a collegian of the old school survive under an educational dispensation which lethargically connives at the downgrade trend of culture. There's no need of mincing words where even college presidents speak out frankly. The general course of the country is set against the concerns of culture, and the educational policies are warped to the dominant tendencies of the age. Democracy seems bent on vulgarizing education, and the great Moloch of business, too, is at work preparing education for its Gargantuan taste and appetite. The numerical mania has taken a grip on the university. *Intra! Salvere jubemus,* we salute youth from our portals. Why frighten the entrant with Latin? Let us say in plain English, "Pay as you enter." The main question is not how good is our show, or how select the audience, but how many are willing to pay the price of admission. After making the limits of freshman enrollment coextensive with the birth-rate of seventeen years before matriculation, we are trying our utmost to please our pay-guests so as to induce them to stay. The college to-day, says one of our most enlightened presidents, exists to give the student a happy life. It is wrought in the image of the undergraduate.

It follows logically that in these circumstances it behooves the professor to become a true reflex of the same image. It serves him better to be a good scout than a good scholar. The "popular prof" is not he who makes a bold stand for scholarship but he who comes nearest to the pragmatic standards of the populace as refracted through the student body; consequently, the young instructor who looks after the main chance is more likely to imitate his sophomore students than his senior professors. The rapid augmentation of the teaching force, due to the abnormally multiplied attendance, has done its share to dispel the professorial aura, and so, too, has the ranging of the academic business into all sorts of profitable side lines. No halo of great learning surrounds professors of advertising, embalming and cheer-leading. And inasmuch as to the layman a chair of milking looks no higher than a milking stool, he naturally

has the same esteem for our contemporary Jameses, Whitneys and Newcomes as for practitioners of the aforementioned arts and sciences.

V

One can only wonder that in the face of all these discouragements persons of marked ability do still espouse this calling. For undeniably the new college teacher is as "competent" as the old; often more so in specialized vocational knowledge, as he is likely to have wasted less time on "mere literature" and such frills.

Nevertheless, the supply of able-minded recruits for the profession is not in keeping with the great demand. Although the development of graduate schools promises to provide plenty of teachers, the number of first-rate men whose undergraduate curriculum is shaped with an aim to teaching, and who enter the graduate school properly prepared, is negligible. The recognition of the latent danger of this situation was the mainspring of certain large-featured enterprises for the improvement of the professorial fortunes. Sometimes they merely plan for the increase of salaries, as when a John D. Rockefeller sets fifty million dollars as a bait to lure the quadruple amount into the trap for that specific purpose. Sometimes, on the other hand, the concern for the material sustenance of the profession and for its social dignity is explicitly coupled with the ulterior care for the propagation of science. The most striking example is furnished by the Carnegie Foundation for the Advancement of Teaching.

The very name clearly shows that the ulterior aim of this foundation went beyond assisting the professor in his valiant struggle with poverty. At the same time, the teacher was recognized as the most vital factor in the advancement of teaching; hence this foundation at first addressed its efforts to the invigoration of the teaching force through timely superannuation of the invalid and the time-worn. Also it was expected that by liberal protection a superior class of persons would be attracted to the profession, for it was thought essential that faculties should be made up of those richly endowed in culture and intellect. Thus the foundation hoped to avert what has, alas, by now befallen—namely, the rebuilding of Academe into a "Temple of Mediocrity." Unquestionably, improvements ensued upon the foundation, mainly through the raising of standards —for the time being, at least—as a preliminary for admission to its benefits. Whether permanent improvement came *propter hoc*, or merely *post hoc* need not be gone into here. While many people attribute the credit to Mr. Carnegie's munificence and Dr. Pritchett's far-sighted educational statesmanship, others will side with President McCracken's opinion that the process was inevitable and would have come about quite independently of that influence.

At all events, the expansion of its scope and the assumption of varied and expensive functions led gradually from a chronic reduction of the annuities to their sweeping abolition, and in the end to the institution of an insurance plan in lieu of the original system of pensioning. President Pritchett and his board found a rational sanction for their altered course in their stated conviction that the pension system was selfishly exploited both by institutions and individuals. Having dismissed the professorial tribe from his paternal solicitude, Dr. Pritchett eventually confessed the opinion that private donations for any educational purpose are questionable. It is no far cry thence to the conclusion that all charity should begin at home, and better stop right there.

Whether the foundation has missed its unprecedented opportunity to lift higher education permanently to a significantly higher plane, it is too early to decide. So far, its visible effect on education has

been mixed: good mainly in that it drove some too patently inferior colleges out of business; bad mainly in that it fortified the "Interlocking Directorate" and widened the gulf between the teaching and the administrative branches of the profession.

Perhaps by the shift in the policies of the foundation more than any other single motive the college professor was at last driven to the very uncongenial remedy of self-help. The Association of American University Professors was organized to fight his battles and promote his collective interests. By the irony of chance the guides of its destinies in the earlier era were predominantly professors of philosophy, whose habit of chopping logic and splitting hairs gave constant curb to action, and to-day, with our esprit de corps so largely evaporated, it is highly questionable whether enough strength and unity survives in the profession for articulate protest under any provocation. The local chapters of the A. A. U. P. are occupied with endless discussions of minor matters which properly belong to official faculty jurisdiction, while the annual general convention faultlessly formulates wise and useful propositions of which the authorities rarely take any notice at all. Like the Carnegie Foundation, the Association of American University Professors has been of a mixed effect. It has wrought some good, in stemming the tide against deprofessionalizing our vocation. On the other hand, it has shown itself weak in will, lacking in creative power and incapable of giving inspiration. It has, therefore, fallen short of legitimate expectations.

For my *dimitto nunc*, a bright word of cheer might perhaps seem more in order than the occasional touch of flippancy which my presentation of this saddening subject has indulged in. It will be readily supplied by the rampant optimism of the profession. I have to confess myself so unacclimated to the educational topsy-turvy that I have to laugh at it now and then to stop myself from weeping. And I will not even close with an orison for better things, for I should be praying to gods that are no more, than which earth holds no sharper exile. I am too near the end of my career to be swayed in my viewpoints by personal hopes and fears. Moreover, I know that to most of my colleagues the change of which I complain looks like honest-to-goodness progress. The American college has passed through several distinct stages of control. At first it was governed by the church. Later, by the president and the trustees. Faculty control, as the next natural step, was reached by but a few institutions. The present trend is very rapid toward government by the community and the students. In the immediate future, success in the professorial career must hinge on an ability to please the students and the town. There is no collective disposition among the advocates of education to pull against the mock-educational tendency of the times. I have stated things as I see them, and have no remedy to offer. Only this curious question: Shall some tidal wave of culture return the college professor soon or late to his former honorific place in society? Or is the demobilization of the professor a premonitory phase of the disarmament of old moral and intellectual world forces?

WHO IS A MORON?

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THE answer to this question is of general as well as scientific interest. The term "moron" originally brought into the language for specific scientific use seems to have filled a long-felt want in the public mind, and to-day one meets it in polite conversation, in popular literature of all kinds, from newspapers to novels and poetry, as well as in scientific writings.

The origin of the term is briefly stated. There have been for many years at least three different terms commonly used to apply to persons of defective mentality. These were idiot, imbecile and feebleminded. Each in its turn had originally been applied as a very kindly designation of mentally deficient people. Idiot, which sounds so harsh to-day, was originally taken over from the Greek language "idiotes," meaning having an individuality of his own, or in a sense peculiar, not an obnoxious term to be applied to a serious mental defective. But of course in time it came to take its meaning from that to which it was applied. Likewise, imbecile, which means literally leaning upon a staff or needing support, was also a friendly term. Still more recently, the expression feebleminded has come to be applied to these people with the result that it is coming to be a little unpleasant in its implication.

In 1909, the American Association for the Study of the Feebleminded appointed a committee to devise a classification for the feebleminded. The writer was a member of that committee and made the report which was presented a year later at the annual meeting held at Lincoln, Illinois. The Binet-Simon tests of intelligence with their age grading had just come into use and it seemed feasible to use the terms already referred to for defectives of different age levels. Accordingly, the plan presented was to call those defectives who had no higher intelligence than that of two-year-old children, idiots; while those who had intelligence from three years to seven years, inclusive, were to be called imbeciles. So far, so good. There was, however, a third group with a mentality of from eight to twelve. It was at first thought that we could call them feebleminded. This indeed is the custom in England, but unfortunately for our plan, in the United States the term feebleminded had come to be applied generically to the entire group of mental defectives and every state institution in the country was called an institution for the feebleminded. It was obviously too late to restrict the use of the term feebleminded to the highest group. The only thing that could be done was to keep the term feebleminded in its generic sense as covering the entire group of mental defectives and to select a new term for this highest group. Various words or expressions were tried, such as "deviates" "the almosts" and several others, none of which seemed to have the right sound.

The term "fool" in its good old English signification seemed to be exactly what we wanted. The definition given is "one lacking in common sense, in judgment, or in intelligence." But, good as the term was in old English and fitting exactly the group, it is nevertheless taboo

in modern usage. But no such objection existed for its Greek equivalent "moron." Moreover, fortunately the Greek root "moros" has not been brought into English, except in two words, and it is compounded in each case with another word. The rhetorical term "Oxymoron" is applied to an expression that sounds foolish, but in reality is very witty or sharp "oxus." And, secondly, it appears in the word sophomore, which was a comic word coined years ago by college men to apply to the second-year class, the "sophos," meaning wise, indicating what they thought of themselves, and "moron," meaning foolish, what the upper classmen thought of them. These usages would have no effect upon our proposed use of the term. Consequently, our highest group of the feebleminded was called "moron" in the report of this committee on classification. The report was accepted by the association and the classification adopted.

It will be noted that according to this a moron is a feebleminded person who has a mental age of anywhere from eight to twelve years. But as already indicated the public has found the term so useful that it is being used indiscriminately and without regard to its original definition. As used to-day, it is applied to anybody who is a little bit dull in intelligence, or even, as some one has expressed it, to any one who does not agree with you. Most people to whom the term is applied in this broad sense of rather dull or stupid probably have an intelligence of not more than twelve years. Now if all such people were really feebleminded, there would be no difficulty in the matter. But unfortunately for this problem, such is not the case. There was a time to be sure when we rather thoughtlessly concluded that all people who measured twelve years or less on the Binet-Simon scale were feebleminded. However, we had already begun to discover our error when the war came on.

The war led to the measurement of the intelligence of the drafted army, with the result that such an enormous proportion was found to have an intelligence of twelve years and less that to call them all feebleminded was an absurdity of the highest degree.

Three years ago, William Allen White published an article with the caption, "What is the matter with America?" His answer to his own question was in brief, "The moron majority." According to the army results he was not far from right, if we take the term "moron" to include all the twelve-year intelligences—and add a few of the thirteen years. Of 1,700,000 soldiers tested, forty-five per cent. did not get above the twelve-year limit. Inasmuch as 1,700,000 men were a fair sample of the entire population, we conclude that these figures hold for the people of the country. But if a moron is a *feebleminded* person, it is evident that these people are not morons. To put the question another way: some people with ten-year intelligence or eleven-year or twelve-year *are* morons, but the great mass of that group *are not* morons. Now what are the distinguishing marks? We shall discover before we are through that the answer to that question raises several others of considerable importance, even involving the interpretation of the laws by which we take care of the feebleminded persons in state institutions. If a moron is a feebleminded person, then are not all persons with a ten-year mentality, for example, morons or feebleminded? To answer we must first ask the question, "Who are feebleminded?"

And now must our nakedness be exposed! In this year of grace, nineteen hundred and twenty-six, after three quarters of a century of dealing with the problem and at least a quarter of a

century of intensive study of it, we are still limited to a definition of feeblemindedness that is unscientific and unsatisfactory. We have no absolute criteria of feeblemindedness. In the definition generally accepted by English-speaking people, we appeal to no less than three sciences for our criteria. Our accepted definition reads, "a person of defective mentality (psychology) existing from birth or an early age (biology) whereby he is incapable of competing in the struggle for existence or of managing his own affairs with ordinary prudence (sociology)." Such a definition is not scientific because it is not definite. It is not satisfactory because it is not usable in all cases. It is not definite because in the first place it does not tell us what we mean by a *mental defect.* How low in the scale of intelligence must a person be in order to be a defective? We have already said that at one time we thought twelve years was the limit, but we know that most of the twelve and even the ten and the nine are not defective. Secondly, we say that such defect exists from birth and early age. Existing from birth is definite; existing from an early age is indefinite. However, in both of these cases, it would only be necessary to determine a point by common agreement as the result of study and a determination of the consequences. But the third science appealed to is more hopeless than all the rest. Who can tell exactly what we mean by being incapable of competing in the struggle for existence or of being incapable of managing his own affairs with ordinary prudence? What is ordinary prudence? What do we mean by managing his own affairs? Must he never take advice from any one? Moreover, in this case even if we could decide what we would mean by such expressions it would not remain constant even when so settled. My two-year old nephew is of idiot level and I may call him an idiot without hurting his father's or mother's feelings provided I use the right inflection and have a twinkle in my eye. But he is not feebleminded because he is not defective. He has all the mentality that his age calls for. If when he is three or four he still has only the mentality of two, he will be defective and it will be a mental defect that existed from an early age. So far two thirds of the definition makes him feebleminded. But how about the third? Well, he is incapable of competing in the struggle for existence or of managing his own affairs with ordinary prudence, but that is not because of his mental defect, but because of his age. But again, suppose he is four years old with a mentality of two, still it can not be said that his inability to compete or to manage his affairs is the result of his mental defect. It is just as much the result of his chronological age. And yet such a boy would probably be diagnosed as feebleminded. Certainly, if we adopt the I. Q. system, for his I. Q. would be only 50, well within the limits of feeblemindedness.

Let us now assume that this boy has grown up to fifteen years of age and has a mentality of ten. He is within the moron limit for mentality, and although he is fifteen years of age he is incapable of earning his living and of managing his own affairs with ordinary prudence. He is therefore, according to all the criteria, feebleminded. We will therefore place him in the institution for the feebleminded for care and training. Let us say that he stays there five years. He still has the mentality of a ten-year-old boy, but in those five years he has been very carefully trained. He has learned to take care of himself, to dress and undress himself, to take care of his clothes, to keep himself decently clean. He has learned to work, he can plow and harrow and hoe corn and drive horses, he can

earn twenty or forty or perhaps fifty dollars a month at such work. He has even learned to take care of his money. In short, he is no longer incapable of competing in the struggle for existence or of managing his own affairs with ordinary prudence. Is he feebleminded? Is he a moron? Not according to the definition. He has a mental defect because he has only ten-year mentality; the defect existed from an early age, but the rest of the definition does not apply. Was he feebleminded when he was sent in to the institution at the age of fifteen? Certainly, according to the definition. Then he has been cured of his feeblemindedness! That seems to be an inevitable conclusion. He was feebleminded five years ago, but now he is not feebleminded. But we have always said that feeblemindedness was incurable. "Once feebleminded always feebleminded." We were evidently in error and yet the difficulty is more the result of our definition than anything else. The boy is just as mentally defective as he ever was. Just as feeble in mind as he was five years ago. That condition has not been changed. Yet he was not so defective and so feeble in mind that he could not be trained to become self-supporting and capable of managing his own affairs.

The reader is already asking what that hypothetical case proves. Does such a thing as this ever happen? Yes, that is the reason we are discussing it. We have not resurrected a dead issue for the sake of manifesting our marksmanship. What we have described has not only happened but is happening all the time. It has been happening for years, but we did not know it. Every institution for the feebleminded has some inmates who are sent there as feebleminded but who are no longer incapable of managing their own affairs. This fact has now been demonstrated to us by the work of Superintendent Charles Bernstein, of the institution at Rome, N. Y., who has proved that these people have become capable, by actually putting them out to take care of themselves. He was careful at first to give adequate supervision until his case was proved, but there is no longer any doubt about it. Not only that, but Dr. Walter E. Fernald, late of Waverley, Massachusetts, made a careful investigation of the children who had been taken out of his institution by their friends or relatives. This investigation showed that the great majority of those who were of the moron level were getting along very satisfactorily. A similar study at the Vineland Training School shows the same results. *We are curing some feebleminded in all our well-managed institutions*—if you choose to put it that way. It will perhaps be better to conclude that we have so trained a few of the feebleminded that they are capable of taking care of themselves. Whatever we choose to call it, it is a fact of tremendous significance. But we must be careful that we make no mistake as to what it signifies.

First of all, some of my readers have already raised the question as to the advisability of letting these people go out into the world, even though they can support themselves. Is there not danger that they will marry and bring into the world feebleminded children and so continue this defective race? Yes, there is considerable danger of that, *if it is a danger*. Let us look at it a little more closely. Just what is the danger? First, that we are propagating the feebleminded. Yes, but we have learned how to "cure" them, and when cured (trained) they are very useful. They are happy in doing their kind of work that you and I do not want to do—positions that it is hard to get people to fill. In other words, *we need these people.* They are an essential element in the com-

munity. Why should we be afraid of their having children and bringing up a family like themselves? But suppose they have children that are of a lower intelligence than themselves who can not be trained, will always be a burden upon society? Yes, that would be serious. But there is no indication that that happens in any considerable number of cases. Accidents occur to all classes. Sometimes highly intelligent people have the misfortune of bringing into the world a defective child. There is no evidence that these morons would be any more unfortunate. Perhaps our ideal should be to eventually eliminate all the lower grades of intelligence and have no one who is not above the twelve-year intelligence level. Aside from the impossibility of eliminating half of the population, one may very well question whether such a thing would be desirable, even if it could be done. One thing remains to be considered, the tremendous significance of education for the moron.

The problem of the moron is a problem of education. There would be very few, if any, morons in our institutions for the feebleminded if we had not been mistaken in our theories of education. Henry Fairfield Osborn has said, "The true spirit of American democracy that all men are born with equal rights and duties has been confused with the political sophistry that all men are born with equal character and ability to govern themselves and others and with the educational sophistry that education and environment will offset the handicap of heredity." On the basis of this supposed equality, we have concluded that what is good for one is good for all in the way of education and until quite recently have insisted upon the same course of study for all children. We have now discovered our error, but we are slow to put our new knowledge into practice. The most marked psychological characteristic of the moron is that he is unable to generalize, to handle abstract ideas or to use general principles. He can not handle abstractions or general principles. That being the case, it is as useless to try to teach him subjects that involve generalization and abstract ideas as it would be to train him to run a foot race if he had been born without legs. From this, it is clear to see why we have in the past turned out of our schools so many boys and girls who could not compete in the struggle for existence nor manage their own affairs with ordinary prudence. We have kept them in school and tried to teach them abstractions and general principles, things that they could never learn. The result has been that when they left school they were not only not prepared to do anything by which they could earn a living but they were *discouraged* and *disheartened* and often times *disgruntled* and *anti-social.* It can not be wondered at that many of them became delinquent and finally, criminals. Now that we have learned the facts, the solution is easy. Teach them the things they can learn instead of attempting to teach the things that they can not learn and we will send them out of school trained and even skilled in the doing of things that will enable them to compete in the struggle for existence and in habits that will insure their managing their affairs with ordinary prudence. Moreover, they will have that priceless boon which the moron of the past never did have, namely, the consciousness of *ability in some line,* the *joy of creation* and of independence.

And what kind of training is it that will produce this very desirable result? The reader who wants a complete answer to that question and a demonstration must visit the institutions for the feebleminded where that work has been and is being done. As already stated, Dr. Bernstein, at Rome, New York, has

made some of the largest and most convincing demonstrations, but the same kind of training can be seen at Vineland, New Jersey, at Letchworth Village in New York, at Waverley and Wrentham in Massachusetts—in fact, in most any of the state institutions, although some have gone much farther than others in appreciating the value of industrial training. In brief, the work consists in training these children to work and make with their hands things rather than training them to read and talk about things. These people can all be trained to work efficiently with their hands and when trained they will continue to work efficiently at the thing that they have learned. *They can never be trained to exercise judgment in critical situations.* Therefore, their work must be more or less of a routine nature. But they are not unhappy at this. In fact, they enjoy it if they are not worked too hard and are well treated. This means that it is desirable always for some one to have a certain amount of oversight of such people; in other words, they should always be regarded more or less as children. Provision should be made for their playtime and rest as well as for their work. Our classes for backward children in the public schools have begun to work on these lines, but very few of them have been able so far to carry the plan out to its logical conclusion and to train these children to do the things in school that they are most likely to have an opportunity to do throughout life. This is the problem of the moron.

THE UNNATURAL HISTORY OF THE CLOTHES MOTH

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INTRODUCTION

SHAKESPEARE tells us that, "All the wool that Penelope spun in Ulysses' absence did but fill Ithaca full of moths." Can you picture the expression on Ulysses' face when, on his return from Troy, he examined the condition of his civilian clothes? You and I have seen a suit riddled with holes in less than a year. What must have been the condition of Ulysses' clothes after twenty years! I leave you to finish the picture.

When economic pressure turned my attention to the clothes moth with a view to their destruction a happy idea occurred to me. I reasoned thus. If the Mediterranean flour moth which fills our corn meal with its webs is controlled by a little wasp whose larva feeds upon the caterpillar of the moth, may not this same wasp baby feed on the nearly related clothes moth caterpillar? My imagination progressed faster than my experiments, and I saw every clothes closet in the land harboring a little wasp's nest. I was doomed to early disappointment. Although the wasp stung the clothes moth caterpillar and laid its eggs upon the caterpillar's back, and although the baby wasp sucked the clothes moth caterpillar with as much zest as a baby sucks a bottle, yet the experiment failed completely because the bottle was too small. The caterpillar was soon sucked dry and I had the pitiful sight before me of a baby wasp starving to death. With such infant mortality I saw the race of wasps was doomed. Therefore I turned my attention elsewhere in attempting to control the activities of the moth.

ETYMOLOGY: ORIGIN OF THE WORD MOTH

WHEN I talk about moths I am embarrassed because different kinds of insects are called moths. Here we have large flying insects with gorgeous wings like the cecropia moth. There we have the young of the carpet beetle, little hairy creatures about the size of a grain of wheat, which we call the buffalo moth. The fish moth hastily takes to cover under our books and papers. The word moth must have more than one meaning: that of a flying form and that of a crawling form. What do we mean when we say, he "slashed at a moth"? On account of the apparent confusion in the meaning of the word, *moth*, I digress temporarily from *entomology*, the study of the moths, to *etymology*, that study of "roots" which is not usually included in botany.

That great authority, the Oxford dictionary, suggests a double origin for the word moth, one from the same root as midge (mug) and the other from the same word as mouth (motha). I beg to differ with the scholars who compiled the dictionary, because little evidence exists for this idea. I find, up to the middle of the sixteenth century, moth, spelled in ways most unsimplified, as *mohthe* (900), *moththe* (Piers Plowman, 1361), *mought* (Wycliffe, 1381), *mowthte* (1449), *motes* (1520), *mothes* (1551),

referred to anything that consumed and to the clothes moth in particular; as in the Bible, "For the moth shall eat them up like a garment and the worm shall eat them like wool" (Isaiah LI, 8). Floyd writes in his translation of Swammerdam's "Book of Nature," London, 1758: "This little creature, the butterfly, is commonly called a moth but it is noxious on no other account but that it lays those spheroidal eggs out of which the real moths or eating worms are produced in hangings, clothes, etc." In this sense the word appears in the first encyclopedias and in the first dictionaries.

In the time of Shakespeare (1596) people had seen the flying adult arise from the devouring caterpillar. So the name included the flying form as well as the worm. In the "Merchant of Venice": "Thus hath the candle singed the moath." Bacon (1626), a little later, writes in his "Sylva Sylvarum": "The moath breadith upon cloth . . . it delighteth to be about the flame of a candle." Charleton, still later (1668), states, "The moth-fly produced out of the clothes worm."

In encyclopedias the word was early defined to include the flying form. Thus, in Chambers Cyclopedia (1753), under the heading, Phalena, . . . "the name by which authors distinguish those butterflies that fly at night . . . and we vulgurly moths." The sense that the word moth includes a flying insect, for some reason, does not appear in the dictionaries until very late. Webster, the American, in the first edition of his dictionary, 1828, first defined the word to include a whole group of Lepidoptera, while as late as 1885 some English dictionaries do not define moths as flying insects.

We must conclude, therefore, that the word, moth, had not a double origin but that, coming from the same root as mouth, it came to mean something that devours, a maggot. Roland (1656) says, "There are all sorts of Blattae (cockroaches), the soft moth, the mill moth, and the unsavory or stinking moth." Vegetius (1748) has it, "Small maggots or moths which others call lice cause intolerable pain in the intestine." Because one kind of moth was seen to develop into a flying form, a moth-fly, the name, moth, became transferred to a group of flying insects. Yet, to this day, we call the larvae of certain beetles which devour wool, "buffalo moths" and another little insect which devours paper "the fish moth."

Ethnology: Customs of Man and the Clothes Moth

The necessities of life for civilized man are food, shelter and clothing. This insignificant clothes moth has for thousands of years affected the customs of human beings by attacking one of the necessities of life, wool, the principal material that man uses to conserve the heat of his body. That the moth was a pest to the ancient Hebrews the Bible testifies in many places, but in no place does it give a hint as to how the people reacted toward the moth, except in horror.

Aristotle, at the time of Alexander the Great, in his "History of Animals," Book 5, Chap. 26, however, does give us a hint. "There are other small animals," says he, ". . . some of which occur in wool and woolen goods, as the ses (clothes moth) and these animals come in the greatest numbers when the wool is dusty." We infer by this that the housekeeper in the Greece of Alexander the Great brushed clothes to keep out the moths.

From the writings of that good old Roman country squire, Marcus Porcius Cato,[1] known in history as the elder Cato, we learn that clothes stored in a box in which amarca has been rubbed

[1] "De Agricultura," Chap. XCVIII.

will be safe from moths. I wondered for a while what amarca could be, until in the works of the Roman agriculturist, Varro,[2] I found that it is a substance prepared from the watery dregs of olives after the oil has been extracted. This liquid, after being reduced by boiling to one third its bulk, is recommended as a disinfectant, a sheep dip, a cattle food, and a fertilizer—surely a handy thing to have around the house.

With Pliny (70 A. D.)[3] the methods of conservation became more and more fanciful. "A suit of clothes placed upon a coffin will be forever proof against the teeth of moths." Recipes of this sort were common in the middle ages. A few dead Spanish flies (a kind of beetle) suspended in a house will drive away moths, while clothes "wrapped in the skin of a lion have nothing to fear." We have no way of judging how many housewives followed these methods. In France, about 1737, we know from Réaumur[4] that it was the custom of housewives to beat and brush their hangings and clothes at least once a year and store their clothes in boxes with pine cones (Fig. 1).

[2] De Rerum Rustica."

[3] "Natural History."

[4] "Histoire des Insectes," Tome III, Memoires 2 and 3, 1737.

That moths influence our modern complex life can not be doubted. Twice a year, spring and fall, for several days at a time, moths direct the steps of the housewife and are the things uppermost in her thought. Indeed, her mind is full of their webs in the daytime and she dreams of them at night.

Too often is a horrible truth discovered—moths in the winter flannels! See! Little Archie's sweater a mass of holes! Gloom sweeps through the household. The housekeeper recalls the labor of certain spring days when all the winter clothes were sunned, beaten, brushed, sprinkled with moth balls, laboriously placed in newspaper bundles and stored away on shelves in the closet or in trunks in the garret. Having followed the best available practice, why is little Archie's sweater in rags? Life is not worth living!

If we are of an analytical turn of mind we will find that, like philosophers, the housekeepers of this day and generation are the followers of several different schools of thought. In one household we might find a follower of the newspaper school, a school which teaches that there

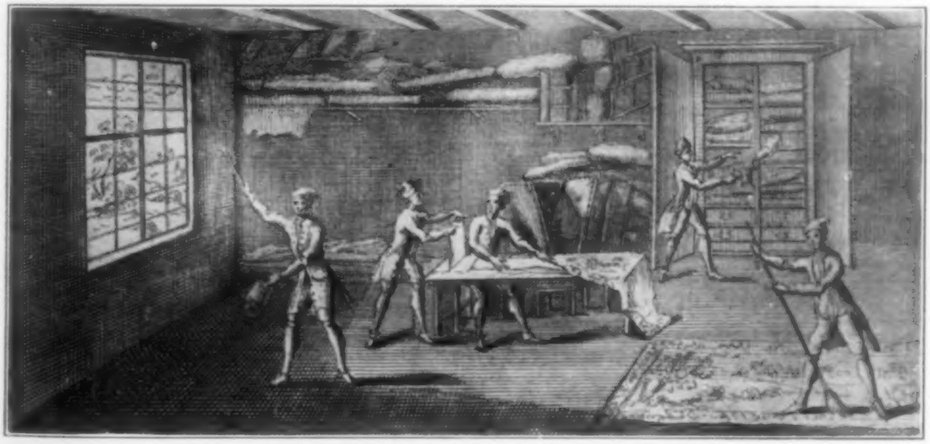

FIG. 1.—THIS PICTURE FROM RÉAUMUR'S HISTOIRE DES INSECTES SHOWS US THAT THE MODERN HOUSEKEEPER HAS NOT PROGRESSED MUCH FURTHER THAN HER ANCESTORS LIVING IN 1730, BEATING THE GOODS ONCE OR TWICE A YEAR BEING THE METHOD USED.

is something in printers' ink which is death to moths; in another house will live a disciple of the cedar school, one who puts her trust in a cedar chest and cedar shavings. As we look about we will find a host of schools such as the moth ball, gum camphor, turpentine, keep-the-moth-fly-away-by-any-means, and others too numerous to mention. Sometimes we find a cautious housewife who, to be on the safe side, follows all these schools at once. Although all precautions have apparently been taken, yet occasions arise where damage occurs, notwithstanding all that has been done.

Réaumur and Greasy Wool

A FRIEND of mine once related the sad story of his Navajo blanket. For years the blanket lay on the floor untouched by moths. It became dirty, so he had it scoured. In the summer which followed it was ruined by moths. This experience recalls to my mind the experiments of Réaumur.

Early in the eighteenth century René Antoine Ferchault, Seigneur de Réaumur, performed the first experiments designed to end the veracious career of the clothes moth caterpillar. In passing I may mention that it was Réaumur who first put the manufacture of steel on a scientific basis, who invented porcelain glass and who gave Central Europe a temperature scale. Through his studies of the arts of France and the biology of French animals he added millions of louis d'or to the wealth of his native country. Like Pasteur, his worth was recognized during his lifetime and honors, material and immaterial, were heaped upon him.

Réaumur has written two memoirs on the clothes moth.[5] In the first he records observations on their life history and in the second careful experiments on means for their destruction. Réaumur presents the method of science (the hypothesis, the controlled experiment, the organized record and the conclusion) in such a modern manner that I can not help quoting a small portion of the second memoir.

> I have taken glass bottles to hold my moths so as to be able to observe them and by preference I have taken those cylindrical jars called powder bottles of which the opening is about the size of the bottom. In each bottle I have put a piece of blue or gray cloth . . . with some of the chemicals that I wish to test. Into this I throw a score of hungry moths and cover the top with paper. These experiments are of such a nature that without great ingenuity they can be indefinitely varied and are not too difficult to repeat if we wish to leave no point uncovered.
>
> Although the moths are common enough yet I have needed so many thousands of them in my experiments that at times I have been embarrassed to know where to procure them. Those whom I set to hunt them have searched thoroly all the eaten furnishings before they could collect a hundred. On the other hand moths that I raised in my bottles, which have changed to butterflies, which have laid eggs, have given me a most abundant crop. Still I have failed to get enough. I have searched in the proper season for the butterflies that the moths produce, and have shut them up with pieces of material on which they have laid their eggs. Although they are perhaps less fertile than when at liberty yet they multiply about twenty fold. . . . (In this way I procure) all that I wish. . . .
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> . . . . We never see moths attached to the fleece which covers the back of sheep. . . . Fleece removed from the back of sheep which has received no treatment are hardly more damaged than that which is still on the backs of the animals. . . . In the case of wool the very first thing that we do is to make it suitable for moths to eat. These wools that have received no treatment are called greasy wools. They are sensibly greasy to the touch of our fingers. The first process is to remove the grease and then the moths do not spare the wool.
>
> . . . . This suggests to us to add to the woolens that we use some of the original grease that has been removed and see if we can make them distasteful to the moths, although we add so little that it is not apparent. It is necessary therefore to prove either that the grease is deadly to the moths or not merely to their taste. I have shut up some very vigorous moths alone

[5] "Histoire des Insectes" (1737).

with greasy wool and others with pieces of cloth that I have rubbed upon the wool. I have seen the one and the other on short commons for several weeks following while a third series that had other wool at their disposal gorged themselves. The former came to eat and at length turned into butterflies. Times of famine force them to eat food that in less happy times is repulsive to them we conclude that moths will live on wool even if it is little seasoned to their taste.

I have inclosed others with pieces of wool of two colors one of which was rubbed against greasy wool and the other had not been so treated, the one was blue and the other was gray. In other bottles I made the opposite arrangement that is I put the gray pieces that had been made greasy and the blue pieces that were not. The moths constantly ate the one and never touched the other. It was rare that they ever detached a hair.

By the same methods as we preserve little pieces of cloth so we can preserve great hangings. . . . Nothing is easier than to rub the hangings with greasy fleece to protect them from moths. The materials are not altered the least in the world. By the eyes you cannot tell the rubbed part from the part not treated.

In the place of rubbing the furnishings and other materials with fleece we can get the equivalent effect by several methods. The grease you can get at an apothecary's where it is called lanaline. If you wish to get it cheaper it may be procured from the hot water in which (crude) wool has been washed. Without going to the trouble of trying to separate the grease from the water, all that is necessary is to dip a brush in the water and lightly pass it over the goods to be preserved.

Besides lanaline (the grease from wool), in a similar way, Réaumur experimented with about everything found in the pharmacopeia of his time. Turpentine, of all that he tried, proved the most effective in killing the larva. One drop, he states, will kill all moths in twelve cubic inches of air.

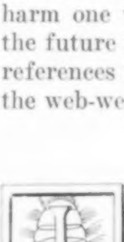
Before discussing the results of Réaumur with lanaline and turpentine we must consider the animals with which he worked. Although two species of carpet beetle larva and three species of moths will eat wool, we will pass by the carpet beetles and consider but two of the clothes moths species. The two clothes moths of importance can be distinguished best by the houses which the caterpillars build. The web-weaving moth, *Tineola biseliella*, builds a permanent house, while the case-carrying moth, *Tinea pellionella*, is a nomad and carries his house about with him. The former is our common moth, while the latter was the moth described in Réaumur's memoir and which is apparently the clothes moth of literature.

Although the case-carrying moth is described as common in this country recent investigators,[6] including the author, have failed to find a single one.

With the web-weaving moth the author repeated Réaumur's experiments with greasy wool, washed wool and washed wool treated with lanaline with no conclusive results—the moth seemed to thrive on all three grades of wool about equally well.

He repeated also Réaumur's experiments with turpentine, but found that it only killed in relatively tight containers and then failed to kill every caterpillar. Therefore it appears that the case-carrying moth, *Tinea pellionella*, behaves differently from the web-weaving moth, *Tineola biseliella*, and things that will harm one will not harm the other. In the future it must be understood that all references in this work have to do with the web-weaving moth.

Repellents



IF defensive tactics will drive away the clothes moth, why start an offensive? Can we raise effective defenses about our goods? Greasy wool, turpentine, gum camphor and naphthaline have each been reported in this class. If repellents are of relative value—that is, if only a few of the enemy survive on our goods the defenses are worse than useless. We demand absolute protection, even if we

[6] Benedict, *Science*, Nov. 9, 1917, p. 462; *Science*, Apr. 19, 1918.

must drive our trenches far into the enemy's country. It behooves us, therefore, to inquire whether absolute protection is afforded by repellents.

Benedict[7] performed experiments directed to find dyes for woolen goods which would either repel or poison moths, and would not hurt baby, as he expressed it, when he sucked mother's dress. His experiments, which were cut off by the war, led to no conclusions.

Greasy wool proved no repellent in the experiments of the author on our web-weaving moth. Indeed the grease seemed to add a necessary condiment as the caterpillars flourished upon it. When it was gone you could hear them gnash their teeth for more! Turpentine, gum camphor and naphthaline in open cages had some repellent effect, but some bold moths held their noses, slid surreptitiously in and laid a few eggs on the exposed material which had been dusted or sprinkled with the supposed repellent. If not inclosed in airtight containers with turpentine, camphor or naphthaline the larva will not perish. Nevertheless, liberal applications of naphthaline crystals will give some protection and in certain cases may be quite effective.

Although a number of other substances have been found to slightly repel the moth, but since they fail to give absolute protection, none are to be recommended at the present time.

Ethology: The Habits of the Moth

BEFORE we can plan a campaign to exterminate any animal we must know the principal events of its life history, its habits and its instincts. By such knowledge alone can we find at what stage it is most vulnerable and what instincts or habits may be made to aid in its destruction.

The web-weaving clothes moth, *Tineola biseliella,* from the tip of the long thin abdomen of the female moth-fly deposits the little white eggs under the loose hairs that cover the woven yarn. These eggs, three of which, if set end to end will scarcely reach across the head of a pin, must not be confounded with the feces of the caterpillar, which are frequently called "eggs" by the housewife. If not disturbed at the end of seven days the eggs will hatch; out of each will appear the little white caterpillars with yellow heads which are the bane of the housewife (Fig. 2). At first this worm is so small that it will scarcely reach across the head of a pin. Very slow is the growth. In the summer three months and in winter nine months intervene before the juicy caterpillar is half an inch long and is ready to transform into the winged form, the moth-fly. Although the caterpillars feed on wool throughout this period of their lives, when they are small, it is on loose hairs that they browse; it is only when they are large that they eat holes in the goods. As these little moths are semi-transparent, the color of the cropped wool in their intestines renders them so nearly the tone of the goods on which they are feeding that they are easily overlooked. The observant housekeeper, however, is sure to spot them by the little silken tunnels that they build. For this purpose not only do they use the silk produced by themselves but also they use bits of wool and even their own feces. As Réaumur exclaimed, "They are Hottentots indeed who build their houses out of dung!" It is in such a house or cocoon that the moth transforms and from which it emerges as the little yellow moth-fly. From a devourer and consumer, the moth becomes a creature in itself unbelievably harmless; unable to feed, for its mouth is incompletely formed, it flutters around for a brief ten days, finding its mate or laying its eggs. Its duty to its race complete, it flutters to the floor and dies.

[7] *Science,* April 19, 1918.

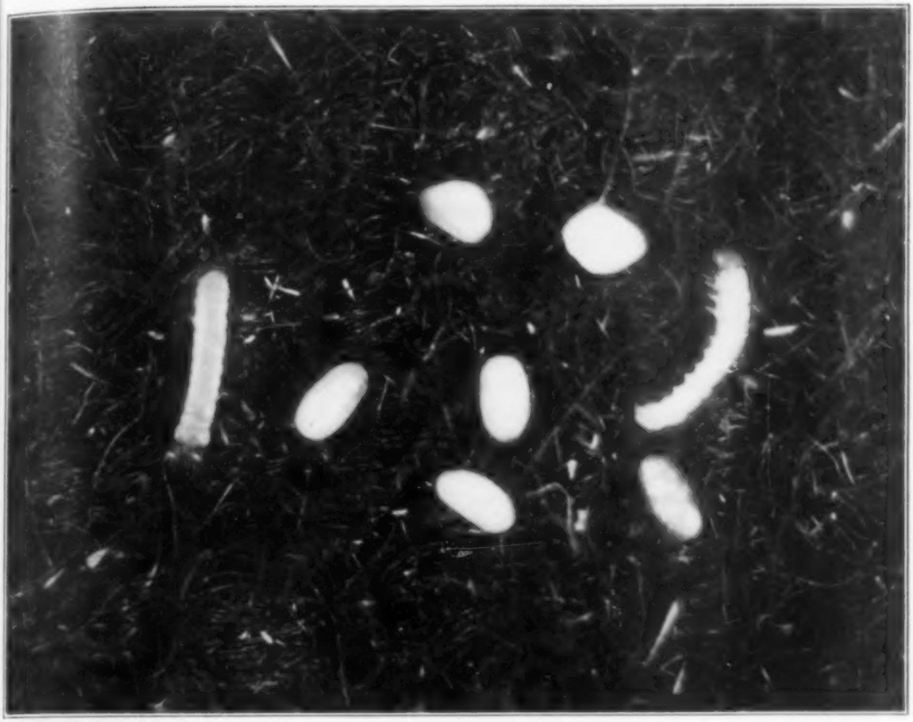


FIG. 2.—THE TRANSLUCENT EGGS OF THE CLOTHES MOTH ARE QUITE SMALL (THREE END TO END WILL EXTEND ACROSS THE HEAD OF A PIN). WHEN LAID UPON WOOL, THE NEWLY HATCHED CATERPILLARS START TO FEED AT ONCE.

The food of the clothes moth caterpillar is hair. Hair, like the flesh of an animal, is composed of protein, but to be a food must be dissolved. This the clothes moth can do. In its stomach, cells produce a ferment that can render this hair protein soluble so that it can be absorbed and assimilated. All the nourishment of the caterpillar comes usually from this one source, but under certain conditions it can live on finger-nail clippings and feathers as well. It is well to remember that the cracks in our floors contain plenty of food for moths.

The clothes moth manufactures drinking water.[8] The hair contains among the various elements which compose it the element hydrogen. This combines with the oxygen of the respired air to form water. Although the caterpillar never drinks a drop of water in its life, yet, as everybody knows, it is a very juicy animal.

On the conservation of water the life of the moth depends. Since it must manufacture all it demands, so it must see that none is wasted. The two ways by which animals lose water are by evaporation from the surface of the body and by the excretion of urine. Evaporation limits the habitat of the moth to more or less humid regions. The moth, by a peculiar method of excretion, conserves the water in the urine.

Experiments have been performed which indicate that the web-weaving clothes moth does not thrive in all climates because it can not conserve its

[8] Babcock, S. M., 1912.

water supply. Therefore, in a hot dry climate, such as southern Arizona, in summer; or in the sun on a sunny day in the east, water is removed faster than it is manufactured and death ensues from drying up. On the other hand, a hot moist climate is bad because mould grows in the wool. A cold dry climate is harmful because it slows up the life processes of the animal. Freezing does not kill, but quick thawing does.[9] A warm dry climate, such as we have in our homes in winter, does not kill but slows up the development of the animals. Clothes moths do best in a warm moist climate, such as the eastern states enjoy in summer, for here it is not moist or hot enough to grow mould in the wool, but in the dark it is moist enough to prevent excessive evaporation.

In most animals the elimination of the nitrogen of the body waste is in the form of urea, which is dissolved in water and passed out of the animal. The clothes moth, in common with birds and certain desert animals, excretes these wastes as uric acid in little crystals which pass out almost dry. In food and drink, therefore, the clothes moth is peculiar.

Economic Entomology: The Means to control the Pest

In planning to keep moths out of goods it is well to know that a large voracious caterpillar feeling the pangs of hunger will eat a hole through newspaper (Fig. 3), but finely woven glazed cotton goods will turn their fangs. However, a newspaper bag will stop the little ones, so if bags of glazed muslin are not available paper is better than nothing in which to store our goods.

Two of the most important instincts of the moth and the moth-fly are their attraction to dark places and their desire to feel the pressure of two surfaces against their bodies. Thus they crawl between cracks leading into boxes or folds in the goods. Few cracks between the lids of boxes or trunks are too small to keep them out. Therefore, bags of some kind are necessary—cheese cloth is worthless, and paper not sure; bags of glazed muslin answer the purpose.

Goods that are handled as often as once a month or clothes that are worn at frequent intervals have nothing to fear from moths. Since the eggs are extremely delicate, a touch with a fine camel's hair brush will break their shells. The caterpillars indeed have an instinct which often leads to their destruction. Their reaction when frightened is to "play 'possum." They become rigid, bent into a half moon. If not in a silken tunnel, disturbing the goods easily displaces them. Shaking, followed by brushing, will rid the goods of most of the eggs and caterpillars. It fails when newly hatched caterpillars are present, caterpillars that are so small as to be invisible to the naked eye, a few of which not displaced by brushing will be sure to be overlooked. To kill all they must be "gassed."

The method of work in studying lethal gases is very simple. Into two

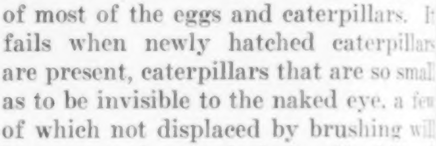


Fig. 3.—Contrary to the usual experience of housewives the clothes moth caterpillar, if starving, will gnaw a hole through a piece of newspaper to get at food.

[9] Howard and Blaisdell, Bull. 22, N. S., Bur. Ent., U. S. Dept. Agr., 1900.

wide-mouthed bottles an equal number of caterpillars are placed on two similar pieces of an old blanket. The top of each bottle is now covered with a piece of porous paper, such as Scott tissue toweling, and snapped to the neck of the bottle with a rubber band. One of these bottles is placed in a trunk in which some poisonous gas is to be tested and the other bottle, called the control, is kept under similar conditions but not exposed to the gas. If, at the end of two days, a week or ten days, we find that the caterpillars in the trunk are dead and the controls are alive, then we can draw the conclusion that it was the gas that killed them. To be sure that this conclusion is correct, the result is verified by repeated trials.

By these means a large number of substances have been tested. Some have been common substances, such as tar camphor, and others less familiar, as para-di-chlor-benzene. Each substance was tested first in a corked bottle with the caterpillars and then in a bottle covered with a single layer of Scott tissue toweling. If the worms were killed under these conditions, they were then introduced to the same substances in a trunk. It was soon found that no substance, not even that evil-smelling carbon bisulphide, as recommended by entomologists, was strong enough to kill the caterpillars in an ordinary trunk. As the gases used were in every case heavier than air, they tended to pass through the porous sides and bottom and did not fill the trunk with vapor. The next step was to render the trunk reasonably gas-tight. A heavy gas is like water: if we have the trunk airtight we can fill it up to the level of the lid crack before the gas will overflow out into the room. The best means to render the trunk gas-tight was found to paraffine the inside of it. This is easily done. A quarter of a pound of paraffine is melted in a pan on the stove, then carried out of doors, an important precaution, and poured into a quart of gasoline. The resulting yellow liquid is applied to the inside of the trunk with a brush, the precaution having been previously taken to paste muslin over any large holes. A trunk so paraffined should hold water. If it will hold water it will also hold gas. Under such conditions and under these alone will carbon bisulphide, tar camphor or para-di-chlor-benzene kill moths. Although a few moth balls placed in the pocket of Cyril's coat or moth balls placed in a cardboard box may repel the winged moth-fly, yet, if one caterpillar is overlooked in the brushing, considerable damage must result.

The red cedar chest is an old friend among our defenses against the moth. Experiments performed by the Department of Agriculture[10] have shown that our trust is not placed in vain. It has been demonstrated that the value accrues from two facts, first, because the chests are tight containers similar to the paraffine trunk and, secondly, that some sort of fumes are given off by the cedar wood which will kill young caterpillars and eggs, although not injuring the older ones.

It is needless to say that for killing moths the various substances examined were of very different value. Indeed, while some were found to be of worth, most were valueless. Some gases that will kill moths will also injure man, so that these were discarded in the beginning. Some others will destroy the color of the dyes. Some are inflammable; some difficult to procure; and some too expensive. Without further discussion I may state that naphthaline or ordinary tar camphor in the long run is the best. As used in the household the fumes are harmless to man; it will not destroy the color of the goods; the fumes are non-

[10] Black, E. A., U. S. Dept. Agr. Farmers Bull. No. 1051, 1922; U. S. Dept. Agr. Farmers Bull. No. 1346, 1923; U. S. Dept. Agr. Farmers Bull. No. 1353, 1923.

inflammable; it can be procured at any drug store; a little goes a long way; and it is quite inexpensive. It is ordinarily carried in stock in two forms, either as crystals or fused, when it is known under the name of moth balls. In a paraffined steamer trunk one half a cent's worth of crystals is equal in killing power to about twelve and a half cents' worth of moth balls at the present price of naphthaline (25 cents a pound), but the crystals evaporate four times as fast. When used in an ordinary trunk the amount should be doubled. Although one ounce of crystals or a pound of moth balls in a paraffined trunk will quickly kill the eggs and the newly hatched caterpillars, to kill the large ones ten days is necessary. It is on this information that the recommended practice is based.

This practice is planned to adhere as closely as possible to that already in use by most housekeepers. It varies from this only where the ordinary methods are worthless. The reason for each step should be in mind. Indeed, if this is so, goods need not be ravaged by moths.

(1) The goods are placed in bags of any closely woven cotton material or in bags of stout paper, the open ends of which should be so secured that there will be no crack or crevice by which a worm or mothfly could gain access. I know of two good reasons why this should be done out of doors on a sunny day. First, direct sunlight with a temperature of 112° F. will kill the larva in a few hours; and, second, since mothflies hide in dark places none will be about when the goods are placed in the bags.

(2) The bags are now placed in a paraffined trunk, upon the bottom of which is sprinkled a few ounces of crystallized tar camphor. Why? In the first place, the trunk is paraffined to prevent the escape and hence the dilution of the gas. In the second place, crystallized naphthaline is recommended because it is about four times as powerful as moth balls.

(3) In this trunk the bags should remain over ten days. Should there be a fat caterpillar hiding in the pocket of father's overcoat, ten days in an atmosphere of naphthaline will end his career.

(4) After the ten days are up the bag may be removed to a shelf in a closet or to any other convenient storage place. This will leave the trunk available for more bags of woolen goods. The last load may remain in the trunk all summer. In using the trunk or chest I must insist that three precautions be taken. As a killing agent outside of a tight container, tar camphor is not sure; as a repellent it is of doubtful value, so trust the bag to keep out the moths. Do not open a bag after it has been in the naphthaline trunk or in the chest. A microscopic caterpillar may be hovering around the opening only too anxious for a chance to rush in. If the bags are properly labeled as to contents, they will not need to be opened very often. Occasion sometimes demands that we gain access to a sterile bag. After the bag is opened and closed and after the opening has been secured the bag should again be placed in the trunk or chest. If these cautions are heeded and precautions are taken, Penelope need not worry over moths.

While every housewife has sufficient resources to paraffine a trunk, yet a few may wish to prepare a more permanent receptacle. Indeed the paraffined trunk may prove too small, as the author's wife discovered. Recalling Professor Howard's[11] description of a chest in the household of a "Washington gentleman," a large chest lined with tin, the author constructed two on similar lines, each as large as two or three ordinary trunks. Substituting galvanized iron for tin and constructing a moth-proof lid crack, his delighted wife can now

[11] U. S. Dept. Agr., Div. Ent., Bull. 4, N. S.

FIG. 4.—A CHEST DESIGNED AND BUILT BY THE AUTHOR FOR THE STORAGE OF WOOL FABRICS. IT CONSISTS OF A BOX 5 FT. LONG, 2½ FT. HIGH AND 2½ FT. WIDE OF GALVANIZED IRON. AROUND THE TOP OF THIS BOX IS BOLTED A 2-IN. X 2-IN. FRAME IN WHICH THERE IS A GROOVE. THE LID ALSO OF GALVANIZED IRON SUPPORTED BY A WOODEN FRAME HAS A FLANGE WHICH FITS INTO THE GROOVE IN THE TOP OF THE BOX; THE GROOVE BEING FILLED WITH COTTON WOOL OR COTTON FELT MAKES A MOTH-PROOF CRACK. (SCALE 1/18 NATURAL SIZE).

store away her furs, the children's "winter flannels" as well as small rugs up to five feet wide, with perfect ease of mind. Charged with two pounds of naphthaline flakes her goods are doubly safe against the ravages of moths. (For details of construction of the chest, see Fig. 4 and Fig. 5.)

Architects, who are ingenious, can even design a moth-proof closet. If a

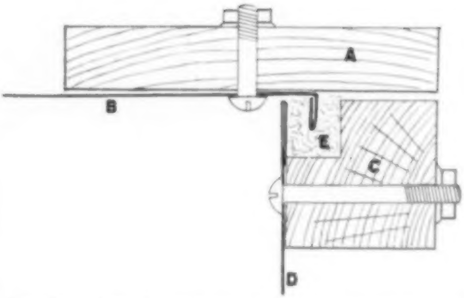
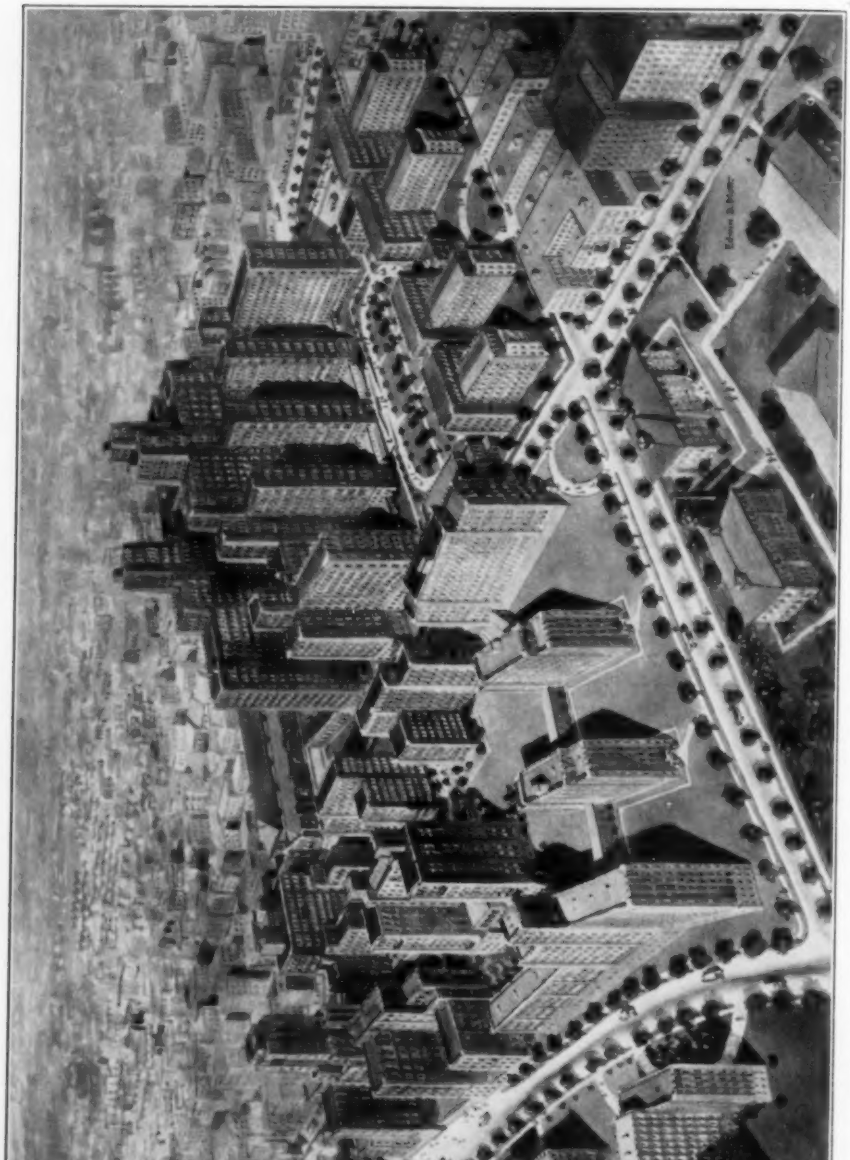


FIG. 5.—DETAIL SECTION OF THE JUNCTION OF LID AND THE TOP OF THE BOX. THIS SHOWS HOW A MOOTH-PROOF CRACK MAY BE MADE. TO THE WOODEN LID FRAME (A) IS BOLTED A GALVANIZED IRON LID (B) WHICH HAS A ⅜-IN. FLANGE ON THE OUTER EDGE. THIS FITS INTO A GROOVE (E) WHICH IS MADE BY THE SIDE OF THE BOX (D) AND A RABITED GROOVE IN THE BOX FRAME (C). THE GROOVE (E) IS FILLED WITH COTTON FELT OR COTTON WADDING WHICH WILL PREVENT THE PASSAGE OF MOTHS. (SCALE ½ NATURAL SIZE.)

small tight door with a rubber gasket is provided and a charge of naphthaline added, one could hang up the winter clothes, even the fur coat, without further treatment with the absolute assurance that no damage will occur over the summer.

We must remember that naphthaline gas kills, that naphthaline gas is heavier than air, that moths seek dark places to lay their eggs, that moth-proof cracks and naphthaline tight containers can be constructed; with all this knowledge before us, the unnatural history of the moth will come to a conclusion.



THE MEDICAL CENTER AS IT WILL APPEAR WHEN COMPLETED.

THE MEDICAL CENTER IN NEW YORK CITY

By C. CHARLES BURLINGAME, M.D.

JOINT ADMINISTRATIVE BOARD OF THE MEDICAL CENTER

DISEASE is as ancient as man himself. Hardly was he born before he began the fight against this, his natural foe. But for thousands of years he clung to the belief that he had been entered by an evil spirit or was being visited by the wrath of an offended deity, and so tried to combat it with charms, incantations, dances and sacrifices to the gods.

It is difficult for the present generation to understand that for these ages past medicine and disease have been surrounded with mysticism and confounded with religion; and yet men born in the nineteenth century believed in these things. Our great-grandparents found it easier to give credence to these ancient doctrines than to the theory that disease was caused by a germ. It was in the early days of our own New England states that there was belief in some of these old conceptions, as witness the Salem witchcraft, when learned men of medicine testified that children with epileptic attacks had been bewitched, and often the "guilty witch" was destroyed by the state.

We can with interest, and even amusement, look back upon the doctors' prescriptions of but a short time ago which contained dozens of ingredients, often of superstitious origin, such as moss from a dead man's skull. As late as 1820 the old Bedlam Hospital in London exploited its insane patients as a source of income, exhibiting them "in cages like monkeys at a penny a look."

Medical science has traveled far since the superstitions of these early days, but most of the journey has been within two generations. Curiously enough, the beginning of this enlightenment did not come about through any understanding of what disease really was, nor as a result of logical thinking in regard to its treatment, but as a by-product of the growing sciences of chemistry, biology, physics and other branches of learning. It was in the reflected light of these growing sciences that scientific medicine had its origin.

Since the introduction into the medical world of bacteriology by Pasteur and Koch, but a generation ago, scientific knowledge in medicine has increased so tremendously as to have broken medicine up into multiple specialties which are ever increasing. So rapidly did this specialization develop that the beginning of the twentieth century found the medical sciences in isolated groups which had sprung up around the work of some particular man or line of research. The resultant lack of coordination has sharply limited progress, and the tendency toward centralization is now as intense as was the preceding trend toward individualized specialization. The medical center movements all over the world are an effort to physically, and thereby intellectually, bring together the scattered elements of medical research, medical teaching and medical care.

These groupings of isolated schools of medicine, dentistry, nursing, pharmacy, public health and social service, with general and specialty hospitals and institutions for research in the different branches, are gradually taking place in varying degrees of completeness, as, for example, at Johns Hopkins University, the Mayo Clinic, Harvard University, St. Louis and in Chicago; but New York, despite the unusual resources at her very

THE PRESBYTERIAN HOSPITAL
WITH HARKNESS PAVILION AND BABIES HOSPITAL FROM THE ARCHITECT'S DRAWING.

door, has been somewhat tardy in taking her place.

The New York Medical Center had its beginning in 1911, when an agreement was executed between Columbia University and the Presbyterian Hospital, whereby the latter became a "teaching hospital" for the university's school of medicine, the College of Physicians and Surgeons. This eventuated in 1921 in the formation of a Joint Administrative Board to develop a complete medical center. These two institutions formed the nucleus of what in the past five years has become a most unusual grouping of long-established specialty hospitals and research institutions. Already, six institutions, each outstanding in its own particular field, have, by executed agreement, taken their places beside these parent institutions.

In 1924 the New York State Psychiatric Institute and Hospital became associated and the following year the Babies Hospital of the City of New York, the Neurological Institute of New York, Vanderbilt Clinic, the Sloane Hospital for Women and the Squier Urological Clinic all became part of the movement. To the Joint Administrative Board were sent additional representatives until to-day it is constituted as follows: Wm. Barclay Parsons, John G. Milburn, Walter B. James, M.D., Dean Sage, Edward S. Harkness, Henry W. de Forest, John Sherman Hoyt, Robert Thorne, Newcomb Carlton, Jackson E. Reynolds and W. E. S. Griswold, with William Darrach, M.D., dean of the medical school, as an advisory member, and C. C. Burlingame, M.D., the executive officer.

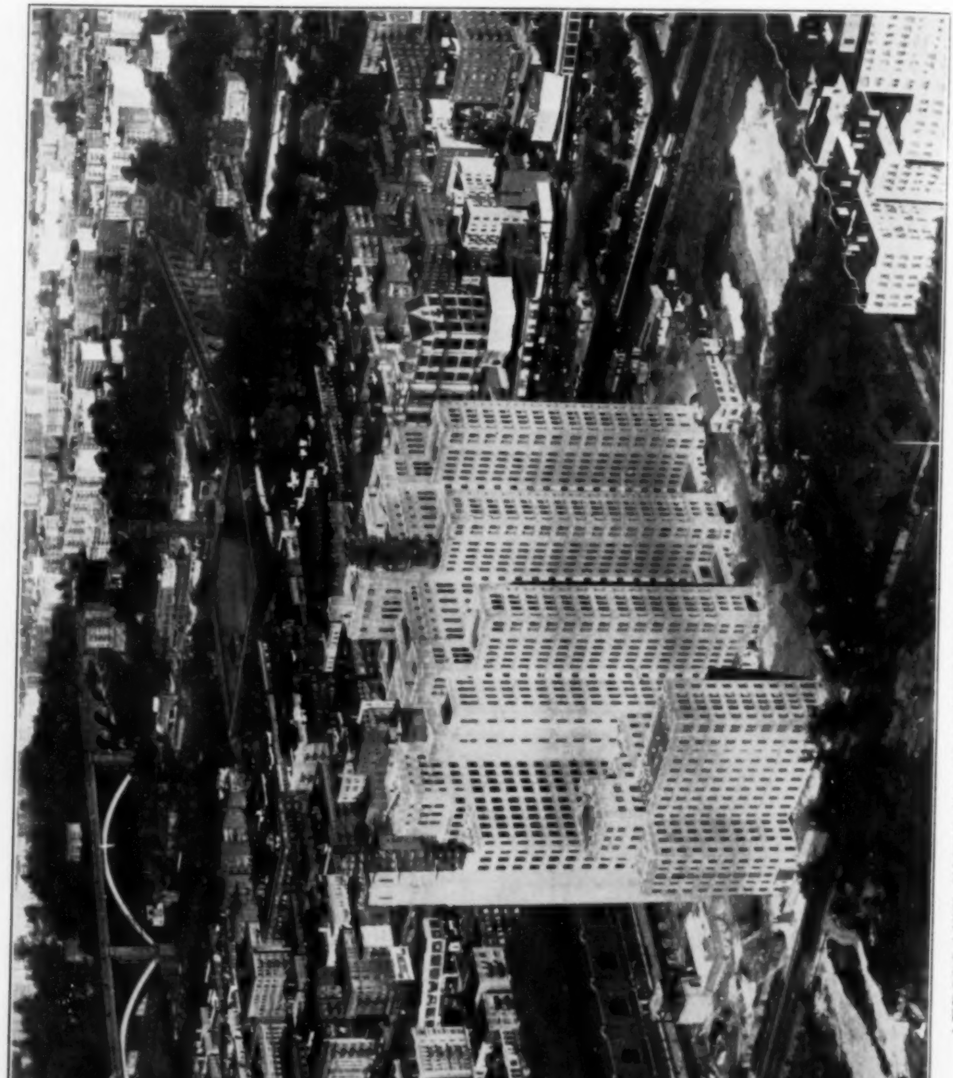
These institutions have all pledged themselves to remove the conditions which for generations have handicapped the care of patients, teaching and research by rebuilding together on a single

THE PRESBYTERIAN HOSPITAL
AS IT APPEARED ON AUGUST 27

plot of ground of twenty acres at Broadway and 168th Street.

Already hospital and school buildings, involving over $19,000,000, are under way with the prospect that in 1928 most of the institutions will begin to operate together as units of New York's Medical Center.

Each institution is being reconstructed with a realization of the responsibility that it must carry as its own specific part in medical progress, but it is inspiring to note that it is also rebuilding with a full realization of the part it must play as one of the group engaged in the high purpose of blending insti-



AEROPLANE VIEW OF CONSTRUCTION TO OCTOBER, 1926.

tutional ambitions with "whatever is best for scientific medicine and for those who are sick."

The practical accomplishments to date are significant. A twenty-two-story combined building, costing nearly $15,000,000 to build and equip, is more than 50 per cent. constructed. Under this roof, all obstacles of distance eliminated, will be the Presbyterian Hospital in the City of New York, the College of Physicians and Surgeons of Columbia University, the Sloane Hospital for Women, the Squier Urological Clinic, the Vanderbilt Clinic and the Harkness Private Patient Pavilion. The resources of these institutions have been conserved by doing away with duplication of effort and unproductive competition between them.

During the month of December the steel work was completed for a fourteen-story building, costing $1,100,000, to house the Presbyterian Hospital School of Nursing. This school is establishing a new policy which limits their students to three hundred as the ideal number that can be taught in a single teaching unit. This policy is another departure from the old order of things when the number of pupil nurses was determined solely by the hospital nursing needs rather than by the ideal conditions for instruction.

Excavations are nearly completed for the New York State Psychiatric Institute and Hospital, which will cost in excess of $1,600,000. This is to be a twenty-story building, with the first ten stories a hospital for a special group of two hundred patients and the upper half of the building devoted to facilities for instruction and for research in the problems of mental diseases. It will become the ultra-scientific center for the New York State hospital system with its 45,000 beds.

The Neurological Institute of New York has completed plans for a million dollar building which will care for two hundred patients, while the management of The Babies' Hospital is completing plans for a 160-bed institution. The actual construction of both of these buildings is scheduled to begin during the winter.

Stupendous as this grouping already is, there are still other branches which must be included before the picture can be called complete. To this end active negotiations are under way for the inclusion of dentistry, which has become so interwoven with the study of medicine that it can not be ignored, for all allied schools and other types of specialty hospitals, even to provision for the care of the convalescent patient.

The entire movement has been referred to in a materialistic way as the greatest building operation of its kind in the world; the expenditure, at one time, for hospital and educational buildings has been pointed to as without precedent; as the highest hospital building in the world, it has attracted attention; as a unique plan of coordination it has become interesting; but it is the opportunity for complete intellectual unifying of scientific medicine in all its branches which has been the impelling motive in the movement.

THE DISCOVERY OF ANESTHESIA

By Dr. C. A. H. SMITH

THE commonplace use of various agents for the relief of pain in surgical operations is taken for granted at the present time, and the most important discovery of American medicine in the last century is in danger of being forgotten. Surgery without anesthetics is too horrible to contemplate, yet not until 1846 was there a practical means of controlling pain. But at the time there were four principal claimants of the title of discovery, all of them Americans and all responsible for so much bickering and blustering that the true magnitude of the discovery was clouded and is to-day forgotten, while all the mechanical products of American ingenuity are still praised as the greatest contribution to humanity.

The slightest operation in pre-anesthetic times was deservedly viewed with horror and repugnance. John Hunter, the famous English surgeon, spoke of operations as "humiliating examples of the inexpertness of science," and of surgeons as "no better than armed savages."

The surgeons themselves looked upon operative surgery as the lowest and poorest branch of the profession, and care and finesse was forgotten in the attempt to minimize the patient's suffering.

Still there were some who became hardened to the profession, and in 1784 one James Moore, a member of the Surgeons Company of London, published a pamphlet descriptive of a "Method of Preventing or Diminishing Pain in Several Operations of Surgery." There was no remarkable advance described in his paper, but the introductory paragraphs are so accurate a comment on early medicine that they are well worth repeating.

He says:

> If any of the professions were in a particular manner to be distinguished by the name of humane, we might naturally expect—it would be that whose particular object it is to relieve the sufferings of humanity. And, if a greater degree of compassion and sympathy were looked for among any one class than any other, we should expect to find it in the breasts of those who pass their lives in the duties of so benevolent a profession as physicians. Physicians have been accused of a want of feeling for the distresses of human nature and surgeons of actual cruelty.

The lack of consideration for those in pain was not, however, due to lack of interest but to a lack of agents to control pain. From the earliest period of medical history there are stories of various schemes to control pain. Opium, laudanum, alcohol and such drugs were tried and found wanting. After Mesmer spread his mysterious doctrines, hypnotism was used with considerable success. But there was nothing that was easily and universally applicable to all cases, and the general public had good reason for avoiding the early hospitals.

It remained for a young American citizen to perfect a process that is still in use with very little change. The natural expectation would be that he would be rewarded for his work, but, to the contrary, never was a man more abused and never were more absurd attempts made to discredit a product of patient and careful experimentation. Even today there are some groups that wish to deny any honor to him, although for the great part this is due to local sectional jealousy and not from the violent per-

sonal hatred that was so evident at the time.

There were several individuals, all of whom were possessed of sufficient experimental information to obtain credit for the discovery, but either through fear, carelessness or lack of proper appreciation of its value they all withheld their knowledge till after Dr. W. T. G. Morton had braved the unknown and demonstrated the possibilities of ether. A careful study of the evidence can not help but convince the unprejudiced observer that Morton was alone responsible for the introduction of ether into use as an anesthetic, although Dr. Horace Wells, of Hartford, Connecticut, and Dr. Charles Jackson, of Boston, were working along the same lines and Morton very probably worked with them to some extent. Dr. Crawford Long, of Atlanta, Georgia, had used ether prior to Morton, but as I shall show later did not fully appreciate the importance of the material.

Morton was born in Charlton, Worcester County, Massachusetts, on August 19, 1819. His education was slightly better than the ordinary and from earliest childhood he tried to fit himself to become a physician. From various reasons, principally lack of funds, he was unable to achieve his ambition and we find him in early manhood shifting back and forth from one job to another. A disastrous business venture caused him to become dissatisfied with a commercial career, and he decided to take up some profession, even though it could not be the very one he wanted. The dental profession had just broken away from medicine and founded its own schools, and as this had some resemblance to his earlier desire, young Morton decided to take up dentistry.

At this period, dentistry left much to be desired. Dr. Chapin A. Harris, a founder of the first dental school, said in 1840: "The profession is crowded with individuals, ignorant alike of its theory and practice, and hence its character has suffered in public estimation—the calling of the dentist has been resorted to by the ignorant and illiterate and, I am sorry to say, in too many instances by the unprincipalled. . . ." This was none too severe an indictment, and it was only through the efforts of such men as Harris and Morton that dentistry was to survive as a separate profession and eventually become recognized as one of public necessity.

The Baltimore College of Dental Surgery was founded in 1840, and Morton was one of its first graduates. While there he met Horace Wells and after graduation they set up in partnership in Boston. As usual with such affairs there was not enough business for both and they separated, Wells going to Hartford and Morton staying in Boston.

At this time there were many lecturers touring the country who gave entertainments at the clubs and lyceums, where the natives of the smaller communities whiled away the winter hours. Among these was a Mr. G. Q. Colton, who came to Hartford and gave a demonstration and lecture on nitrous oxide or "laughing gas," as it was popularly known. When the gas is administered in an impure state the characteristic symptoms of exhilaration are quite amusing to an audience and his lecture was very generally successful. Dr. Wells was very much interested and induced Colton to give a private demonstration on December 11, 1844. At this time Wells noticed that the subject was immune to physical pain. This fact made him wonder whether or not he could use it for his purposes, so he voluntarily took the nitrous oxide and while under its influence he had a tooth removed by Dr. John M. Riggs. This is the first recorded instance of a surgical operation deliberately performed on an individual while under the influence of

nitrous oxide. Wells experimented during the winter and used his own patients as subjects. Early in 1845 he went to Boston to give a demonstration before Dr. John Warren's class of medical students. Owing to poor equipment or haphazard administration he was totally unsuccessful, for the patient cried out, the students jeered and Wells returned to Hartford discouraged and discredited. His lack of experience alone prevented him from being successful, but the entire matter so weighed on his high-strung mind that he retired from practice, and after a short stay abroad he committed suicide. This tragic ending, together with Wells's pleasing personality, did much to bring trouble on Morton's head at a later date. Wells should have all the credit that is justly due him, but if the world had been compelled to wait for some development to come from his work, there would have been a much longer period of time before the process was entirely perfected. As a matter of fact nitrous oxide was practically abandoned until G. Q. Colton resurrected the method in 1862.

Morton had assisted Wells at this fiasco and they must have discussed the subject thoroughly, but outside of the fact that Wells tried and failed at a public demonstration, while Morton tried and succeeded, there is no reason to believe that one helped the other to any great extent. The inhalation of fumes in medical practice was no new feature; in fact, ether was used in extreme cases of consumption and had been used as a local refrigerant at various times. Wells and Morton were working along the same lines and it is no wonder that it is difficult to assign credit definitely to one or the other, for they were associates and students together during the entire period, up until Wells's public demonstration. Morton had begun to work along different lines, and he drew as much inspiration from other sources as he did from Wells.

After the break in partnership, Morton had prospered, in fact, work came in so rapidly that he was compelled to hire several assistants. He had made several improvements in dental technique, and he was one of the best known practitioners in the city. His craving for a medical education still remained unsatisfied, so that in 1844 he entered Harvard Medical School. Morton was required to select one man from among the medical men of the city as preceptor or guide, and he chose Dr. Charles T. Jackson, then acknowledged the foremost chemist of the city and the one man most likely to help Morton in his work. The latter had not completely hidden the fact that he hoped to find some agent capable of deadening pain and Jackson had suggested sulphuric ether as a local application over sensitive tissue and they had discussed the properties of several other drugs at various times. Jackson claimed later that he knew that sulphuric ether would produce stupefaction when inhaled, but he did not make any such assertion publicly prior to Morton's demonstration.

The few known facts concerning ether impressed Morton and he set himself to determine all the properties of the substance. He read what little he could find and experimented with ether on small animals and on himself. It was customary for those that knew a little about ether to inhale the fumes up to the point where dizziness and a slight degree of intoxication was produced. This "ether jag" was well known among medical students and chemists and was practiced more or less openly. Morton tried to carry the state beyond the intoxication stage and at one time made himself deathly ill by inhaling the fumes of ether and opium together. His attendance at the medical school must have

been rather sketchy, for he was carrying on these experiments together with his dental practice at the same time.

On September 30, 1846, he administered the ether to one Eben Frost for the extraction of a tooth. The next day the Boston *Evening Journal* published a news item concerning this event. Morton then felt that he must give a public demonstration, so he went to Dr. John Warren, professor of surgery at the medical school, and asked permission to appear before the surgical clinic at the Massachusetts General Hospital. Warren had known Morton for some time and had a good opinion of the latter's professional attainments, so he readily gave consent. In this matter Morton showed that he was willing to jeopardize his reputation by appearing before the same group that had condemned Wells.

At that time the Massachusetts General Hospital was the largest and best in the city of Boston, and in addition to its size and convenience had a surgical staff that was second to none in the country. The building was an impressive structure, standing as it did near the Charles River, where the stately Bulfinch dome and granite columns at the entrance gave an air of dignity and eminence that was well upheld by the standards of medical practice of the institution. It was especially noted for the neatness and cleanness of the interior, a matter that was not as generally emphasized in the hospitals of that time as it is to-day.

The operating amphitheater was directly under the dome and presented a much different appearance than the tiled and aseptic rooms now in use. Around about the old room were large cases containing surgical instruments, while chairs and tables of curious and unusual construction were scattered here and there about the pit. The many hooks, rings, pulleys and other restraining devices that were to be found on the walls all testified to the necessary brutality of surgery of the period. The profound learning of Boston medical society was shown by the presence of an Egyptian mummy whose lugubrious countenance must have been an ever-inspiring spectacle in this den of horrors. The surgeons themselves were accustomed to come directly from their offices in all the glory of whiskers, stove-pipe hats and frock coats, with their spare instruments in their pockets, for sterilization was as yet unknown and patients still died of "bilious fevers" and "humours." There were generally a crowd of medical students on the benches that sloped up in tiers from the pit, and their appearance could not have been very inspiring, for the students of that age were notoriously unkempt.

Warren had set the date for October 16, 1846, and there was to be a representative gathering of the surgeons of the city. There had already been much angry discussion as to the possibility of Morton doing what he claimed, and there was a considerable group that did not like him personally, for his rather shy nature and the fact that he was only a dentist or at best merely a medical student was not entirely in his favor.

There was great difficulty in getting an inhaler suitable for the occasion. As there was no precedent for this work, Morton was accustomed to administer the ether from a bottle with a long snout that was inserted in the patient's mouth and on which he sucked rather than by the administration of the ether with a mask over the mouth and nostrils as is done to-day. The instrument maker was not able to devise an appliance that entirely satisfied Morton and at last he took a hand and made something up to his own specifications. Warren was kept waiting beyond the time agreed upon, and he had about decided that Morton had failed him, so that he turned to his colleagues and said, "As Dr. Morton has not arrived, I presume he is otherwise engaged." Just then Morton came. The patient was willing

to have anything done to alleviate the pain and with few preliminaries the administration began. The spectators rather expected a repetition of the Wells fiasco but nothing unusual happened and the patient soon lapsed into a deep slumber. Morton turned to Warren and said, "Your patient is ready, sir"; and the operation was begun while an astounded silence fell on the room. Accustomed as the surgeons were to the struggles and torture of their patients, this seemed like black magic. Warren finished and broke the silence with, "Gentlemen, this is no humbug." Dr. Bigelow chimed in with, "I have seen something to-day that will go round the world." There should have been a prayer of thanksgiving offered up in the old Puritan town on that occasion if ever.

The news spread rapidly and Morton was called upon to administer the ether for many cases. There were many references to the discovery in the Boston and New York papers, at first quite complimentary, but soon there was criticism and doubt as to the merit of the preparation. Morton had added some aromatic oils to the sulphuric ether to disguise the odor, but he had told the surgeons at the hospital that the active agent was none other than the ether. There was nothing essentially wrong in Morton's conduct in this regard, for he had assumed an immense amount of risk in his experimental and practical use of the agent, and the unpleasant results that followed when the application was in unskilled hands only emphasized this point.

Unexpected opposition came from some of the clergy, based on the assumption that pain was the direct consequence of original sin and therefore must be endured. Morton was threatened with prosecution and there was general condemnation of this terrible drug that set aside the laws of God and man. Dire pictures were painted of the use of this drug by criminals and all the hysterical fire of misguided religious zeal was brought to bear upon the matter.

One clergyman wrote of ether as "a decoy in the hands of Satan, apparently offering itself to bless Woman, but in the end it will harden society and rob God of the deep earnest cries that rise in time of trouble for help." Such stupidity seems incredible, but there were to be even more serious attempts to discredit Morton. No scurrility was too harsh to be applied to him, and the half truths and slighting comment often came from his neighbors and professional associates, the ones who were the first to be freed from that intolerable agony of pain that had so long burdened the human race.

Following the custom of the time, Morton patented his discovery. There is no doubt but that he hoped to profit by his effort, and in any other branch of endeavor there would have been no objection. However, there has always been considerable feeling among the medical and dental practitioners that humanity had need of every process for the alleviation of suffering without let or hindrance, so that rights and patents held by any one practitioner are foreign to the spirit of medical justice. Be that as it may, Morton gave his formula freely to the Massachusetts General Hospital without charge and only intended to profit by the sale of the preparation, called "Letheon." But every one knew that he was using ether and there was no particular need of buying a patented preparation when the pure ether could be obtained from a chemist.

It is interesting to note that the physician-author, Oliver Wendell Holmes, in a personal letter to Morton suggested the use of a new term "anesthesia" to describe the state produced by the application of the drug. Dr. Holmes continued as a friend and supporter, and it was only through the help

of such men as Holmes, Warren and Bigelow that Morton was able to weather the storm that was about to break.

The opposition grew stronger within the first few months of the new year (1847), and the storm of protest and recrimination aimed at Morton fouled his fame and even to-day is responsible for the lack of appreciation of his work. The most abominable blow came from the members of his own profession in the form of a manifesto, published in the Boston *Daily Advertiser* and signed by Dr. J. J. Flagg and most of the leading dentists of Boston, making a formal protest against the use of ether and predicting all sorts of dire calamities from its use. This was to confront Morton at every turn and be used to discredit him when he went to other communities.

Cheap cynicism and irony were lavished upon the discovery by jealous medical men from less enlightened areas as follows:

Professor A. Westcott, of Baltimore, remarked that if Morton's sucking bottle would perform all the marvels accredited to it, the proper place for its use would be for squalling infants in the nursery; R. M. Huston, M.D., Philadelphia, "Quackery"; Wm. C. Roberts, M.D., New York City, "Humbug and a patented nostrum."

The editors of a New Orleans medical journal could not understand why the surgeons of Boston were captivated by such an invention, when mesmerism had accomplished a thousand times greater wonders.

It seemed as if the entire medical profession, outside of a few men in Boston, felt personally insulted that they had not been taken into confidence regarding this invention.

The efforts to discredit Morton are too loathsome to repeat. He was persecuted unmercifully, his dental practice broken up, his personal morals viciously attacked and every possible effort made to alienate any affection that his friends might have for him. The attacks were carried into his own home and he and his wife suffered endless humiliation. There was no limit to which his enemies would not go, and at times it was actually dangerous for him to appear in public. When he went to a small town near Boston to escape his persecutors, he was burned in effigy on the streets. Such humiliation is seldom the lot of him who has benefited mankind with one of the truly great gifts.

Dr. Jackson, his old preceptor, had been included with Morton when the patent was taken out. The attorney advised that this be done, for Jackson had prior knowledge of the work and that might have been sufficient to bring the originality of the discovery into question. Jackson had refused to be included at first, saying that he might lose his professional standing by taking out a patent on a secret preparation. This objection he finally withdrew, and when the patent was issued on October 27, 1846, Jackson was a co-patentee. Later Jackson was to claim the entire credit for the discovery in a letter to the French Academy of Sciences, and the final result was an extremely virulent quarrel between Morton and Jackson. The most that can be said of Jackson's claim is that more credence could be given to it if there were any record of his making a public statement concerning the properties of ether, prior to Morton's demonstration. If Jackson did know all about the material and its uses, as he very probably did, he was perfectly willing that Morton assume all the risk and responsibility for manslaughter that attached to the administration of the drug.

An application was made to Congress for recognition of Morton's discovery and to obtain an appropriation worthy of the work. The lawmakers were so hectored and flustered by the claims and

counter-claims of the partisans of Jackson and Wells that they were unable to come to a definite agreement; no credit was given to any one and Morton retired, poorer and more discouraged than ever.

There was an additional claimant at this time, one Dr. Crawford Long, of Atlanta, Georgia. He had seen ether used for jags and sprees, had experimented with it on some patients and, it is said, used ether for anesthetic purposes two years prior to Morton's public demonstration. The evidence is quite obscure on this, but Long himself admitted in the *Southern Medical and Surgical Journal* of December, 1849, that he had not progressed far enough to be sure of his ground. Such action as he took after the public interest in Morton's work would seem to be simply an effort to steal Morton's glory. Long abandoned his experimentation and certainly had no appreciation of the possibilities of the drug. He was simply one of the many others who had the chance to bring the hidden facts to light but was incapable of doing so. Sir Humphry Davy had written of nitrous oxide in 1800, that it was capable of producing stupefaction and insensibility to pain. The materials for all the discoveries that have blessed mankind have stood ready at hand since the beginning of time, but only those who are able to recognize and put the unknown to use should have credit as discoverers.

Wells and Long both deserved better fortune. Jackson has not a glimmer of justification in his claim. Morton succeeded where the others failed but reaped a whirlwind of abuse that was the most humiliating ever visited on a great pioneer.

The shoddy methods used to discredit Morton were entirely unjustified. The only considerable honor that he received in his lifetime was a gold medal from the French Academy of Sciences and an honorary medical degree from an American university. There is every reason why his name should rank with that of the great Americans, for to him must go the entire credit of risking his life and happiness in order that mankind be freed from pain.

The epitaph on his tombstone in Mount Auburn Cemetery at Cambridge best describes his lasting claim to fame:

Dr. W. T. G. Morton
Born August 19 1819.
Died July 15 1868.
Inventor and Revealor of Anaesthetic Inhalation.
Before Whom in all Times Surgery was Agony.
By Whom Pain in Surgery was Averted and Annuled.
Since Whom Science Has Control of Pain.

AN EXPLORER'S EXPERIENCE WITH THE GREENLAND GLACIAL ANTICYCLONE

By Professor WILLIAM HERBERT HOBBS

UNIVERSITY OF MICHIGAN

THE winds upon our planet are set in motion by extremes of temperature between the hot equatorial belt and two vast refrigerating areas which are located, one to the northward over the ice-dome upon the continent of Greenland, and the other to the southward above a similar dome which overwhelms the great Antarctic continent.[1] Of all Greenland explorers five only—Nansen, Peary, J. P. Koch, de Quervain and Rasmussen—have had personal experiences with the glacial anticyclone in both of its major aspects. These are: the calm interior region of excessive cold, and the contrasted outer slope region of violent down-slope winds alternating with occasional calms. Of the five explorers mentioned, two only—Dr. de Quervain, of Switzerland, and Colonel J. P. Koch, of Denmark—have penetrated far into the interior. The Swiss and the Danish explorers have each crossed Greenland from coast to coast near where the continent is widest. Their narrative accounts of these expeditions are closely in harmony, but the technical scientific report by Colonel Koch is not yet in print. It is for this reason that a popular article published in 1914 in the German language in *Ueber Land und Meer*[2] has great interest and significance.

This article appears to be practically unknown to meteorologists or others interested, and as the story told is set forth in clear and forceful language and is altogether the best account of such an experience that anywhere exists, the writer of this article has obtained the permission of Colonel Koch to publish the essential parts in translation.

The transection of the Greenland ice-dome was undertaken by Colonel Koch in the very early summer of 1913. He started out on April 20 from Danmarks-Havn near Cape Bismarck on the east coast in latitude 77°, and came down to the west coast at Upernivik in latitude 72° 30′. This expedition across a barren waste of eight hundred miles of snow and ice was undertaken solely for scientific purposes, and the party consisted of four men, one of them the eminent meteorologist, Dr. Alfred Wegener. For draft animals Icelandic ponies were taken, and the full story of the affection of the men for "Grauni" and the attempt to get this superb animal across to the west coast is one which is full of human interest but which must be left for telling in another place. In what follows we shall use the words of Colonel Koch's narrative in translation beginning with the departure from the east coast:

[1] W. H. Hobbs, "Exploration of the Poles of Wind on our Planet—Radio Talks on Science," SCIENTIFIC MONTHLY, Vol. 22, May, 1926, pp. 453–455. A technical account is contained in "The Glacial Anticyclones, the Poles of the Atmospheric Circulation," Univ. of Mich. Studies, Sci. Ser., Vol. IV, 1926, pp. 198, pls, 3, figs. 53. Sold by the Library of the University of Michigan.

[2] Captain J. P. Koch, "Die erste Durchquerung Mittelgrönlands, Erfahrungen aus der dänischen Forschungsreise 1912/13." *Ueber Land und Meer*, 30 Jahrgang, 1914, pp. 1721–1729 (with 12 illustrations).

The sledges stood in a row loaded and harnessed with the muzzles all turned to the westward. . . .

A sky covered with heavy gray clouds; only in the northeast a weakly glowing light which announced the dawning day; deep bluish tones in the east above the steep rock cliffs on the Mörkefjord, Hellefjord and Teufelkap; bright light yellowish-red colors in the west over the peaks of Queen Louise Land; complete calm, the flag over the "Borg" hung dead against its staff in mournful folds.

I gave the command for the departure. The sledges slipped forward without noise over the soft freshly-fallen snow. . . .

A light breath of wind wafted down from the north over the Storstrommen. The flag over the "Borg" opened out its folds, it nodded and waved to us with its threadbare fringed cloth.

That was the last greeting of our home to us.

It was a hard journey. Each day wind and snow—often stormy blows—and always against us. We learned to know it, this lashing drift snow which filled the air. It whirled up under the hoofs of the ponies and the runners of the sledges; it cemented itself firmly in the woollen cloth, the furs and the hair of the ponies. It penetrated into the skin and burned in the eyes, and we were forced to put on snow spectacles. It almost hid the sun, so that everything became gray in gray. One could no longer see where to place his feet and fell down in the hard furrowed snow, got up, groped about, slipped, and fell again.

In the long run this continual drift snow, which permitted us neither rest nor quiet, was unbelievably exhausting. At first we thought that we had ill luck with the weather. We were inclined to lie still if the drift snow was heavy, for we believed it was more economical to wait for good weather. It tired the ponies to draw the heavy loads in the blizzard; they became snow-blind, their eyes became inflamed and discharged pus. But gradually it became clear to us that wind and drift snow was the normal condition within the marginal zone of the inland-ice. If we wanted to advance over Greenland we must come to terms with the conditions as they really were.

On the 6th of May we passed the outermost nunataks toward the west. Now we had the land behind us and were spared the many curving detours which till now we had been forced to make. Before us lay the vast sea of snow of the interior of Greenland. We were upon the open sea, could lay our course in the same way as the mariner who steers his ship from coast to coast.

From this moment we went on with certainty and uniformly, though slowly—at the average rate of 15 kilometers daily. Exactly this speed which I had laid out in my estimates as fundamental in respect to provisions and fodder. In spite of this, because of its monotony, the journey was extremely wearying. Always the same blue-gray sky, always the same unchanging white snow surface, no clouds, no naked rock peaks which can interrupt the monotony and excite the imagination.

In the measure that we advanced farther, the wind fell off. In the middle of Greenland it became quite calm. The place of the snow drift was taken by mist, which usually in the morning would be so dense as completely to hide the sun. The air was over-saturated with moisture. Clothes, especially furs and stockings, were therefore constantly wet. Only in a few instances did we succeed in drying them to a certain degree.

Yet the humidity never so got the upperhand of us as to become a torment. However, one shrinks from putting his feet into wet socks and kamiks[3] in order to keep warm. That was all, however.

The sun bothered us somewhat more. During the day it overcame the mist, and toward twelve o'clock it fell directly into our faces. We were high up. The barometer reading showed less than 500 millimeters. The air was so thin that it was unable to absorb the ultra-violet rays of the sun which act so injuriously upon the skin. One's skin burned therefore on the face and nose. The cheeks and lips especially became covered by quite painful blisters which exuded strongly. The cold struck into the wounds which made the situation naturally no better.

Each evening we rubbed our faces with vaseline; it did not help particularly. The wounds burst open, however. Tobacco and warm food we could not endure; it burned much too cruelly, and if, unfortunately, one was forced to laugh, the lips at once tore open. Two of us still carry on our faces the clear traces of the bad usage which we suffered.

I am endeavoring in fairness and as simply as possible and without exaggeration to narrate, and yet I have now doubtless conjured up a picture of four tortured men who dragged themselves forward over the high glacier full of bitter thoughts on all the suffering which they must endure.

Yet it was not so. Neither the wounds in the face nor the wet and frozen furs were anything other than the hardships in which one can easily

[3] The fur boots worn in Greenland.

find himself. No! far more were we four silent men who thoughtfully and quietly went forward over the inland-ice. An almost complete lack of anything happening makes for silence. The track of a fox on which we stumbled almost in the middle of Greenland, furnished us material for conversation for three days, and searching reflection also over the question whether perhaps land might be near. A snow sparrow which followed us over the inland-ice was looked upon as belonging to our company on the journey. When he had been away for a few days and we then heard him twittering in front of the tent, it was something so highly interesting that we communicated it to each other and carefully recorded it in our diary. During the march when our stupid little dog chased the snow sparrow, we put on our skis and excitedly followed this chase, whose possible result we were worried about. . . .

As we gradually approached the west coast we had the wind at our backs. We made sail on the sledges, and the journey now went so easily that we no longer needed the pony (only one, Grauni, remained at this time. W. H. H.). We tied him on behind the sledge and let him trot along behind. . . .

Naturally, Grauni did not have enough to eat; we hoped, however, that he would go on. We required indeed no work from him. He was now our passenger and was towed behind the sledge. When he became tired or we were going too fast, we laid him on the sledge on our sleeping bags, spread out the tent over him, and tied him comfortably but securely on the load. There he lay and had obviously a fairly good time while we others drew him.

It goes without saying that in this way the load was heavy. We had, however, the wind at our backs and were going down slope so that the sledge often slipped along quite easily. Now and then Larson sat up in front upon Grauni as the steerer of the sledge and I behind as conductor, and so we sped on down the slope for kilometers with the speed of an express train, while Wegener and Vigfus who followed behind on skis, remained far in the rear.

In the outer part of the marginal zone we encountered the usual hardships; deep snow powder, sharply angular and lumpy ice, turbulent streams of water within deeply cut trenches, and, further, glacier cracks.

After all these efforts to bring Grauni across Koch was finally compelled to shoot him. As a whole the record is a remarkable one and reflects the very greatest credit upon the leader, distinguished alike for courage and fortitude, for far-seeing perception of the fundamental scientific problems involved, and, not least, for a kindly interest in the four-footed but devoted members of the expedition. As stated above, this terse account supplies the best statement based on personal experiences that we have of the essential nature of the glacial anticyclone of Greenland.

OUR AMERICAN FORESTS, THEIR PAST, PRESENT AND FUTURE

By Dr. RAYMOND J. POOL

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ONCE upon a time a weary nature-lover, threading his way through the magnificent forests of the land where rolls the Oregon, sat himself down to rest in the cooling shade of the mighty denizens of that woodland wonderland. The springy litter and the soily, soothing aroma of the vast forest solitude brought instant relief to his muscles and joints, wearied from strenuous climbing, and he fell asleep.

He dreamed that he lived in a goodly land, stretching from ocean to ocean, and among a people the most blest of all mankind. In that land there were wonderful, far-flung forests containing scores of different kinds of trees, each one fitted for a particular use by the citizens of his native land. But his people had been very unwise in the use of the forests that nature had nurtured through the ages, and the vast sylvan heritage was devastated ruthlessly. Three centuries of forest despoliation had offended the gods who rule over the destinies of the woods and they met in the forest near our sleeping naturalist that day in tumultuous protest against such wanton disregard of nature's masterpieces. They were to decide what should be done in order to put a stop to the awful, ever-spreading desolation that had swept across the fair land. Vigorous and effective action must be taken if the land of great waters and of noble wild things was not to be plunged into dire distress for want of an adequate supply of wood and other forest products for future generations.

The debate was loud and long, but at last it was decided by the great host of ethereal beings that from that day each and every tree, of whatever kind and wheresoever it might be in that land, should bear aloft a burnished golden crest. The crest was to proclaim to all mankind something of the meaning of trees and of forests in the economy of nature and of their essential contributions to the continued happiness and advancement of the human race.

At this point, pungent whiffs of resinous smoke from a nearby forest-fire reached the traveler and he was half awakened. As he turned slowly about he noted that every tree in that vast shadowy woodland, from the tiniest seedling to the greatest and oldest of the giants near him, bore the golden crest so recently bestowed with such regal pomp and circumstance. And as he read the words emblazoned there he mused upon a warning said to be displayed on the trees in a certain far-away nation that was once rich in the affairs that make for progress in human endeavor. That nation had deteriorated sadly and was now but a ghost of its former self. The warning which the guardian hosts had left with their representatives in the material world ran somewhat as follows:

Ye who pass by and would raise your hand against me, hearken ere you harm me.
I am the heat of your hearth on cold winter nights, the friendly shade, screening you from the summer sun, and my fruits are refreshing draughts quenching your thirst as you journey on.
I am the handle of your hoe, the door of your homestead, the wheel of your carriage that takes you hither and yon.
I am the beam that holds your house, the board of your table, the bed on which you lie, and the timber that builds your boat.

I am the flimsy sheet upon which you trace the boastful record of your past, and design your uncertain plans for future years, the gossamer tissue with which you garb your passing beauty.
I am the wood of your cradle, and the shell of your coffin.
I am the thread of kindness and the flower of beauty. Ye who pass by, listen to my prayer, and harm me not.

The wayfarer was now fully awakened and greatly refreshed. He resumed his journey as the lengthening shadows crept across the well-beaten, mossy trail. His thoughts were occupied with the dream, and with a review of certain features of the scientific and economic history of our nation that are familiar to few Americans.

When white men first came to America, the area that has become the United States was endowed with superb forests, the equal of which has never been known in any part of the modern world. There were magnificent stands of pine and spruce and hemlock and maple in the Northeast and in the Great Lakes country; of walnut and hickory and poplar and oak and chestnut on the Appalachian plateau and on the Ohio. In the South, the beautiful, park-like forests of yellow pine and swamps rich in cypress and gum awaited the march of civilization. The vast domain of the Rocky Mountains, with its ruffled blanket of evergreens, had not been devastated by recurring fires, and the sylvan splendors of the redwoods and the Douglas fir of the Pacific Coast had not yet been disturbed by man's lust for gold.

It has been estimated that the original forests of the United States covered 822 million acres and that these stands contained the enormous volume of 5,200 billion board feet of lumber.[1] Some five hundred different kinds of trees have been described from these forests. Thus we may understand that the American people are, by inheritance, a nation of exceeding richness in the matter of forest resources and forest influences. Nature has blest us with an unusually rich and varied heritage in the matter of direct forest products, not to mention specifically any of those well-known esthetic and intangible relations that are inherently the attributes of great tracts of woodland.

But from earliest colonial days we have practiced a form of tree-butchery and forest-devastation that, from the very beginning, has threatened the stability and the permanency of this vast storehouse of indispensable national supplies. Our treatment of our forests has been nothing short of disgraceful and shameful.

Two thirds of the original forest area of 822 million acres has been lumbered, culled or burned. Three fifths of our original timber supply is gone. There are to-day in the United States about 135 million acres of virgin growth forests ready for the lumberjack, and about 113 million acres which are only poorly stocked with more or less inferior trees. Our inheritance of 5,200 billion board feet of timber from the forest primeval has been reduced to about 2,200 billion board feet of merchantable timber. And we are yet a very young nation! The most unsightly blot of the whole unfortunate exhibit is represented by the eighty million acres of land, once covered by valuable forest, which are now devastated and must be classified as waste land. What a hideous mockery of American thrift!

The whole unpleasant story of forest wastage in this country during the past three hundred years sounds much like the classic selection from the old reader on how to tell bad news. The forest was an "ever-present and a far-flung menace in the minds of the early settlers." It

[1] I am pleased to acknowledge my indebtedness to the following publications for many of the estimates used in this article: Greeley, "Timber Depletion and the Answer," Dept. Circular 112, U. S. Dept. Agr., 1920; Brown, "The American Lumber Industry," Wiley, 1923.

was spread over the areas badly needed for beans and tobacco and maize. Wild beasts and even wilder and more dangerous men lurked threateningly in its shadowy depths. It is perhaps not surprising that our forebears felt the necessity of clearing off the forest, and even doing it ruthlessly, when they regarded it as such a powerful obstacle and when they believed that the timber supply was inexhaustible.

A few wide-awake American citizens (a pitifully small company) now know how faulty those notions were. Not only are the forests gone, but most of an important host of remarkable game and fur-bearing beasts have gone with it. The same relentless pursuit has coralled the last miserable herd of the buffalo and the carrier pigeon has been exterminated. We have been told that our splendid accumulations of nature's fuels and other minerals have been greatly reduced. Large cities in mining districts of the west, once buzzing and throbbing with the life of a unique period of our history, have been depopulated within a generation. We are aware, if we have looked into this matter at all, that our natural resources may be exhausted and that the end of some of them is already in sight. The last areas of our once vast stands of virgin forests are now being leveled at a startling rate.

The sad fact is that the "average American citizen" has been, and is to-day, too busy "selling" his nation and its natural resources, which are the rightful possession of the whole body of citizens, to stop to ponder about an adequate supply of essential natural resources to meet the constantly increasing and varying demands of the generations of Americans who are to people our states in future centuries. He is likely to take the attitude of the early colonists that such resources are unlimited, so why should he waste any time worrying about the requirements of posterity.

We are using up our forests at an astonishing rate to-day. Foresters tell us that the cutting and loss of merchantable timber represent a volume of fifty-six billion board feet each year. About forty billion feet of this is secured from the virgin forests still standing, and the rest comes from second-growth forests. Our pulpwood, acidwood and fuelwood demands consume fifty-five billion board feet per year, and the most of this wood comes from material too small or for other reasons unfit for the saw. Only about *six billion cubic feet* of wood are *growing* in our forests each year, but we are *removing*, all told, about *twenty-six billion cubic feet* of wood from these forests each year. Recent estimates indicate that our supply of soft-wood timber is being cut 8.5 *times* as fast as it is growing. Trees that are too small for the sawmill, upon which the future supply of timber depends, are being used 1.5 *times* as *fast* as they are *growing*. These are the most stupendous and startling facts that come from a study of the present forestry situation in the United States. We need go no further in our search for a reason why every man, woman and child and every organization of the people of our nation should become everlastingly enthusiastic for the early development of a forest policy that will insure adequate reforestation and the improvement of our remaining forest resources and their perpetuation for all time.

Our annual demands upon the forest call for upwards of thirty-five billion board feet of lumber; one hundred and fifty million railway ties (a single tie contains thirty board feet of wood); six million cords of pulpwood (a third of which is imported); one hundred and ten million cords of fuelwood; five hundren million fence posts; one hundred and seventy million cubic feet of round mine timbers; eight million pieces of poles and piling; and one hundred million board feet for excelsior.

There are many other demands for wood in small unit pieces that pass our notice, but which in the aggregate represent a very large volume. It is said that we use each year nearly ninety million board feet of wood for matches and toothpicks. This volume of wood represents the annual increment in a forest of eight hundred thousand acres. Recently we have heard much about the manufacture of "artificial silk," "rayon," "lustron" and "celanese," etc., as another new channel of activity which will consume an ever-increasing quantity of wood. Already this cellulose-silk industry has developed four different processes of manufacture, and it has been estimated that the total output of these materials for the current year will reach two hundred million pounds.

On the whole it appears that the *annual consumption* of *lumber* in the United States a short time ago was about *three hundred board feet* per capita, and that the *total* consumption of *wood* was approximately *two hundred cubic feet* per capita per annum.

These few data clearly indicate that we are using enormous quantities of wood each year, and it would appear that the volume can not be reduced to any important degree without calling forth very serious reactions in the agricultural, industrial and home-building activities of the United States. The enormous, unnatural, economic tension of the past ten years brought our per capita use of wood down to the point where the country has suffered severely. All this has resulted in the well-known shortage of houses to meet the increased population-pressure of a decade and has occasioned a serious reduction in the output of many industries. With the astounding, nation-wide revival of building operations during the past two or three years, our present per capita consumption of lumber may have reached the alarming total of four hundred board feet!

The above figures are amazing when we compare them with per capita data from various European nations. We find that our consumption of lumber is from 500 per cent. to more than 1,000 per cent. greater than that for the more prominent countries of Europe. In view of this situation we sometimes wonder how long it will be until we too shall be forced to look upon lumber as a very expensive, imported luxury. And when that time comes, we wonder from what sources the imports will come. Prohibitive prices would seem to render large-scale importation of lumber economically impossible now or in the future. Therefore it is all the more imperative that the United States plant and grow its own great bulk of timber supplies.

Our country would suffer irreparable stagnation and damage if we were compelled at the present time to reduce greatly our annual per capita use of wood. Nevertheless, in spite of this very evident situation, we hustle along, unthinkingly, and the ratio of use to production of wood becomes more and more disturbing to a few of our citizens who are most keenly aware of the serious complexity of the problems involved.

In the face of this situation it should be an easy matter to shape public opinion to such a degree that the devastation of our forests and the wanton waste of forest products would be stopped at once. But progress in this matter is discouragingly slow when we think of the rapidity with which many such resources are being exhausted. For instance, the depletion of timber supplies in the United States has resulted more from the *devastation* of our forests than by their *use.* It is difficult to get the great mass of our people vitally interested in the one greatest factor in such devastation, namely, *fire*. Twenty-seven thousand forest fires have been recorded in a year in the United States, not at-

tempting to estimate the number unrecorded. These fires burned over eight to ten million acres of forest land. A single forest fire in 1918 destroyed $30,000,000 worth of timber and other property, and cost four hundred human lives. There were ninety thousand forest fires during 1925! More than two thousand forest fires occurred in a single western state in 1925, resulting in a loss of nearly $900,000. These would be considered tremendous sums of money if they were to be appropriated by legislative bodies for some specific public purpose, say for education.

The great majority of forest fires are caused by human agency, by you and me, if you please, and therefore it would seem that they should be easily prevented. But we don't know, or we don't care, our forests are inexhaustible! A famous forester has stated that 99 per cent. of the forest fires which occur in one of our great timber states are preventable. Lightning seems to be the only unpreventable cause of forest fires.

A great forest fire is a tremendously spectacular affair, but most persons think only of the immediate damage done to the trees by such a fire. The burning down and the scarring of the century-old veterans of the forest are, of course, deplorable effects which are at once evident, but there are many other serious results of forest fires. Forests are often burned over more than once by light fires. The cumulative effect of such repeated fires is well known. This is made evident in reduced growth-rate and in predisposing the trees to attacks from various insect and fungus pests which appear to lurk in the forest awaiting such opportunity. The destruction and the dwarfing of the young growth, upon which the future of the forest is dependent, is one of the most serious consequences of forest fires.

The destructive and desolating effects of forest fires are not limited directly to the trees of the forest, since in many cases the soil is burned and the watershed occupied by the forest becomes greatly modified. All this may lead to excessive run-off, more rapid streamflow, destructive erosion and damaging floods in lowlands far beyond the forest-covered areas. Such conditions as these are well illustrated in a very striking degree in a number of important localities in western United States as well as in many other parts of the world.

Fire is the most dangerous and discouraging factor in the way of successful reforestation in our vast areas of forest land which have been so ruthlessly stripped of their most valuable products. Fire-exclusion must be a cardinal principle of the working plan that is to be at all adequate in the long, laborious and expensive process of bringing the forests back to our deforested lands in all parts of the United States.

Another very unfortunate and serious economic feature of the forestry situation which we have inherited from the past (because of the absence of a wise policy of forest protection and utilization) is seen in the fact that the most important stands of our most valuable timber left are not in the right place. By this we mean that our remaining timber areas, of major importance, are on the rim of the nation, at great distances from our densely populated centers. Forest products flow into such centers only after journeys of several hundred or even thousands of miles and at an enormous cost for freight.

One great eastern state is now paying more than $25,000,000 each year for freight on lumber brought in from other states. The same state pays upwards of $50,000,000 per year, apart from the freight, for lumber which it imports. This is a sad commentary on the much-

talked-of business sagacity of Americans, especially when we understand that originally this state was extremely rich in forests, and that it could have maintained practical independence for all time, in so far as a lumber and wood supply of great variety is concerned. There are many other losses to the state on account of the local forestry situation, so that it has been estimated that this state suffers a loss of $100,000,000 annually, mainly because it failed to establish a satisfactory forest policy years ago.

Foresters tell us that New England retains less than 5 per cent. of her virgin forests and only about 12 per cent. of her original stand of timber. New York State, once exceedingly rich in forest resources and the leading lumber-producing state of the nation, now supplies less than one tenth of the demands of her cosmopolitan population. Pennsylvania, the leading lumber-producing state in 1860, now manufactures annually less lumber than is used in the Pittsburgh area. And so the movement of this great industry has gone, from the northeastern United States in 1850, to the great white pine areas of the Lake States, thence a little later to the famous yellow pine district of the southern states, where it remained about a half century. Finally it has hurdled the "Great Divide" to the Pacific States, and there the last episode of the picturesque drama (or tragedy) of the lumber industry of the United States is now being enacted, in so far as virgin forests are concerned. This last episode is the most feverish and tremendously impressive of the whole cycle. The entire movement has consumed a very brief time as compared to the span of life of many of those giants of the western forests which are now falling under the saw!

Where shall we go next? It's a long, long way to Siberia or to South America or to the Philippines; besides it would take us many years to adjust ourselves to the use of the woods from those lands, even if we might get them.

From that little old saw mill in Maine or Virginia, with a daily output of five thousand feet of lumber, to the modern, log-devouring behemoth, with a daily output of eight hundred thousand feet or more, has been a scant three centuries. The westward march of the lumber industry, briefly noted above, has taken place in three fourths of a century. What is three hundred years in the life of a forest! And what is seventy-five years in the life of a tree! Millions now living will live to see the final exhaustion of our vast original inheritance of virgin forests. It is surely time we were all impressed with the necessity of giving our trees a chance or soon, very soon, as the life of the forest goes, we shall have completed the despoliation begun by our forefathers and wrung the neck of one of our greatest industries. This industry now ranks third among those tremendous businesses which have been so important in making the United States of to-day great.

In the face of the regrettable abuse of our forests, only a few of the features and consequences of which have been noted in the preceding paragraphs, we are compelled to admit that we do not as yet have a public or private policy which seems adequate to insure the recovery of the ground that we have lost. So far we have met with but little success or encouragement in working out plans for the prevention of still further destruction, devastation and waste.

We are not a nation of foresters. The nation has not yet developed a forestry conscience. Forestry is scarcely a quarter-century old in this country. It will be many, many years before we shall have mastered an intimate knowledge of our forest trees and our forests, and the complex economic and social factors involved in their exploitation. But these

are fundamental prerequisites for the development of a scientific program of forest management and a forest policy worthy of the name. Nevertheless, it is to be hoped that we may yet somehow succeed, some time, in restoring extensive forest areas which at least may be reminiscent of our primeval wealth of forest resources. Surely we may also hope to perpetuate for all time, and in continually improving form, those really magnificent forest resources and influences which still remain in certain portions of our land. It is yet comparatively easy for us to lay the foundation for such a fine program, with nature's able help. We can do this if the nation can only focus its attention upon the essentials of the stupendous problems involved before it is forever too late.

We must, as a nation, set going the machinery that will stop the appalling loss and waste of forest products and bring an end to forest devastation. We must discover how to bring back the forest to the vast expanses of the public domain as well as to privately owned lands which have suffered the loss of their forests. We must provide for a more complete scientific investigation of the life-histories of all our important tree species and of the forest types which they form, together with an analysis of the climatic and soil conditions under which they develop. We must also speed up and complete the careful survey and classification of our forest assets which has been under way for many years. Effective legislation must be secured in order that all this may be speedily accomplished on a scale which amply meets the requirements of the nation.

In this way we shall become the creators of a new and vastly important epoch in the history of the development of the industries and the institutions upon which the future of mankind depends. In the words of our President:

> Let us apply to this creative task the boundless energy and skill we have so long spent in harvesting the free gifts of nature. The forests of the future must be started to-day. Our children are dependent on our course. We are bound by a solemn obligation from which no evasion and no subterfuge will relieve us. Unless we fulfill our sacred responsibility to unborn generations, unless we use with gratitude and with restraint the generous and kindly gifts of Divine Providence, we shall prove ourselves unworthy guardians of a heritage we hold in trust.

Let us stop the waste of forest products!

Let us stamp out forest fires!

Let us use our remaining forests wisely!

Let us plant forests!

Let us know our trees and our forests!

Let us give our trees a chance!

THE NEED FOR GAME FISHERY INVESTIGATIONS

By Professor NATHAN FASTEN
OREGON AGRICULTURAL COLLEGE

THE last century witnessed so many new discoveries of a practical character that there resulted a complete transformation in our entire social organization. The perfection of the telephone, the telegraph, the automobile, the steamship, the factory, the radio, and the many, many other useful tools of our present civilization have not only completely overthrown the old order of things, but they have also radically interfered with the balance of nature to such an alarming degree as to bring about the rapid depletion or extinction of many of the most important inhabitants of our fields, forests and streams.

The game fishes have suffered perhaps as much as any of the other useful organisms. Factory pollution, irrigation dams, disease, the development of highways and a host of other similar circumstances have contributed towards bringing about such a rapid decrease in these forms that many of our choicest species have been threatened with complete extermination. Man has long ago recognized this situation and in order to overcome it he has developed the artificial hatchery for the sole purpose of developing, rearing and distributing the fish to the depopulated areas.

The average person thinks that our game fishery problems have been completely solved by the hatchery, but the thoughtful student of the question is not quite so positive of the results obtained. The fact is that we have been hatching, rearing and distributing fish for a good many years and yet it is no exaggeration to state that we have accumulated almost no positive knowledge which would warrant our making conclusive assertions along any of the lines of game fishery practices. There are a great many problems connected with the propagation of game fishes, and some of them ought to be carefully investigated, in order that we might go about the business of developing these valuable animals in a little more intelligent manner.

Where would agriculture, forestry, medicine, engineering or any of the other applied sciences be without the aid of the scientific research worker? Would progress be possible? And yet how different it is in the field of fisheries, particularly that branch which deals with the game fishes. Here there are exceedingly few scientists who are devoting their attention to the innumerable questions of importance which are awaiting solution. While in exceptional instances some effort has been made to secure the services of competent authorities, yet in the vast majority of cases the rearing and conservation of the game fishes has been entrusted to individuals who, although efficient as business men of affairs, nevertheless lack the adequate scientific training which would enable them to carry on experiments that would yield results of far-reaching practical importance. Sooner or later we must come to realize that we can best conserve our resources by knowing and controlling the factors which insure success. Such knowledge can only come through painstaking investigations running over a good many years. In an effort to stimu-

late research along this line, I have tabulated some of the salient problems which might lend themselves to analysis and would result in great benefit to our game fishery resources.

(1) A complete survey of the game fishes of each state, emphasizing such points as distribution, native forms, introduced species and particularly the effects of the latter on the native types. This study would indicate to a state game commission which kinds of species it ought to concentrate its attention upon. In many states there exists the practice of bringing in foreign species of game fish in the hopes that they will adapt themselves to the new localities and afford a source of enjoyment to the sportsman. In numerous instances this has proven to be a costly experiment, because the introduced forms not only killed off the native types but also proved to be a great deal less desirable than the latter ones.

(2) A thorough examination of the present methods of hatching for the purposes of determining whether improvements were not possible. Many of the methods in practice have been in vogue a good many years without change. Are they good, bad or indifferent?

(3) The foods which are most suitable for young fry, particularly of trout fry. At present there is no adequate knowledge upon this subject. Carefully planned experiments ought to be conducted to determine what are the best types of foods for the growth and development of the young fry which are reared under the artificial environment of a hatchery.

(4) The effects of extremes of temperature on the spawn of game fish. In order to shed some light on this question, accurate records ought to be kept on the differences in the mortality rate of normal fertilized eggs which are allowed to undergo immediate development and those in which development was delayed through the agencies of cold storage or freezing.

(5) The best methods of transporting fry over long distances. At present the two serious difficulties in such transportation are (1) the rise in the temperature of the water surrounding the young fish and (2) the depletion of its oxygen content. Can one through experimentation devise suitable means of overcoming these difficulties?

(6) The actual effectiveness of our fish-planting operations. Here ought to be included such points as the best age for planting of the fry and what percentage of them actually survive and reach maturity.

(7) The migrations of game fish, particularly those of trout, are other topics of great importance which ought to be investigated. Many sportsmen feel that in numerous streams which have an outlet to the sea, trout, even though they are planted in the upper head-waters, hundreds of miles distant from the sea, will sooner or later migrate down towards and ultimately enter the salt water, never to return to their former abodes. They think that this reason accounts for the scarcity of fish in many of these streams.

(8) The inauguration of comprehensive surveys of the various lakes and streams in which trout and other game fish are planted, in order to determine whether conditions are suitable for success. At present the planting is done in any body of water that looks good to the naked eye. Assuredly we ought to know a great deal about such factors as available food supply, oxygen content, temperature variations, predatory and parasitic organisms, etc., of a place before any kinds of animals or plants are introduced into it. Knowing these conditions, we can then intelligently fit each organism into that particular environment where it will thrive best. But without this knowledge we are simply

groping in the dark and are powerless to do any real good. These surveys can be carried on simultaneously with some of the other problems mentioned.

(9) The actual effects produced by the closing down of lakes and streams for long periods of time in order to give the depleted fish population an opportunity to multiply and repopulate itself. In many instances it is certain that such a procedure is distinctly detrimental because, in the first place, the fish begin to multiply so rapidly that there soon comes a period when there is not enough food for each of them, and this results in a fierce struggle for existence. Then again, various fish-eating birds and mammals build their nests along the shores of the closed waters and these not only kill off many of the desirable game fish, but they may also act as agents in spreading disease amongst them.

(10) The diseases of game fish and their prevalence in our streams and hatcheries. Here should be included life-history studies of the various parasitic organisms which attack the fish, with emphasis on control measures. The penning up of immense numbers of fish within the limited confines of a hatchery makes it relatively easy for disease to secure a foothold, and this invariably results in the death of a large number of fish.

(11) The conditions of water, soil, climate and the like, which are most conducive to successful hatching operations. Such knowledge would serve as a practical basis for guidance in the establishment of new hatcheries and would also be helpful in advising those citizens who contemplate going into the private hatchery business.

(12) The breeding of game fish, particularly of trout, for purposes of producing types which would have more desirable qualities than the original parent stocks.

These are some of the lines of investigation which would yield results of importance to our game fisheries. To carry them out it would be necessary for every game commission to have not only adequate laboratory facilities, but also a staff of scientifically trained investigators along these particular lines. Every state is face to face with the problem of its declining game and fish resources. The development of good roads and the possession of high-powered automobiles have had the desirable effect of bringing more people out into the open in search of the recreational opportunities afforded through hunting and fishing. But the fact which must be borne in mind by all readers is that the successful business of developing and rearing game fish under artificial conditions depends not only on the possession of suitable hatching plants, but also on some knowledge concerning the life-histories, habits, adaptations and adjustments of these particular organisms. Such a fund of knowledge can only be acquired through the patient and painstaking work of trained scientists, running over a period of many years.

THE PROGRESS OF SCIENCE

By Dr. E. E. Slosson

Director of Science Service, Inc., Washington, D. C.

THE NOBEL PRIZES

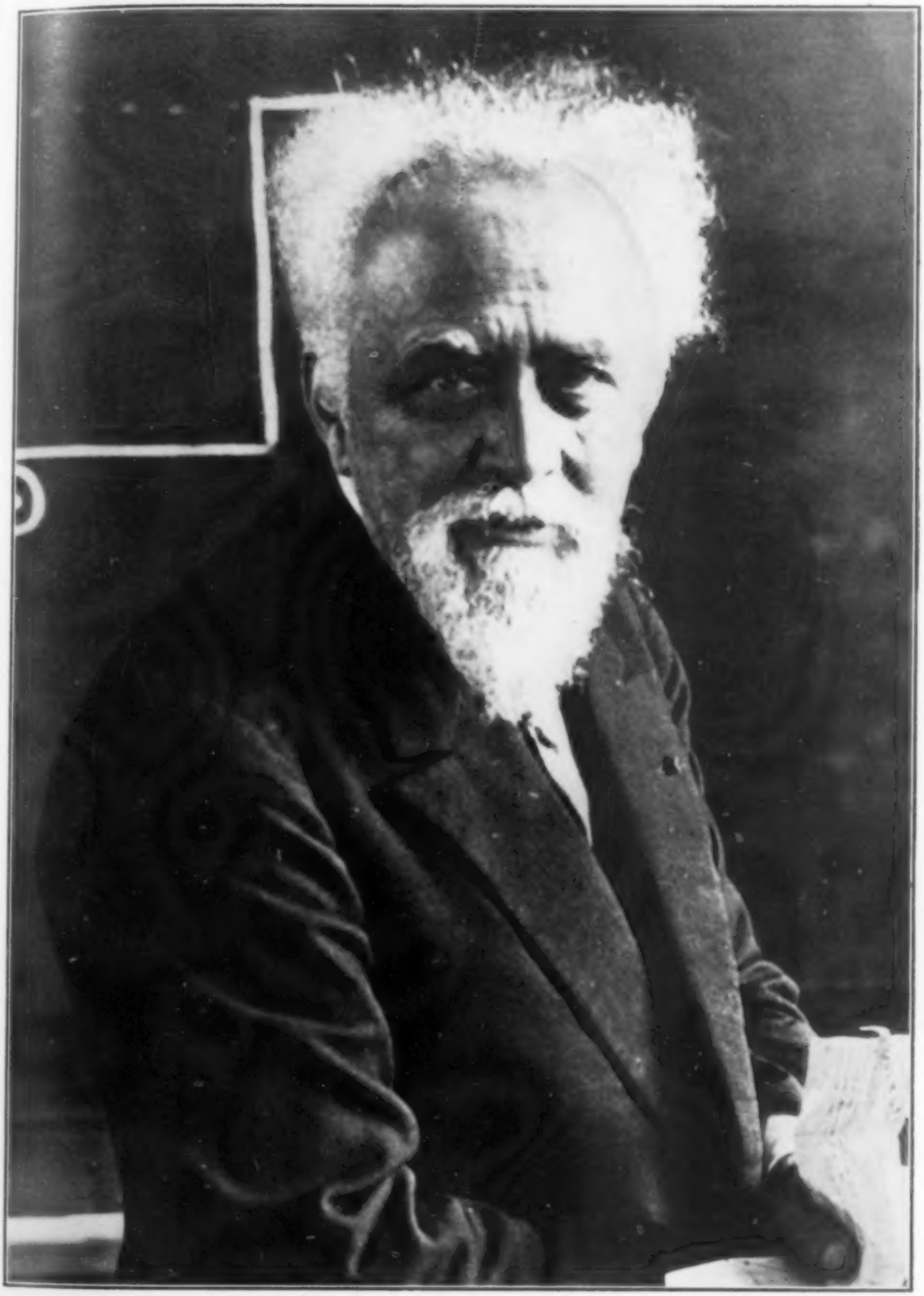
Nobel prizes were presented to five men of science by the King of Sweden on December 10. Germany maintains its leadership in the number of scientific men worthy to receive the prize, as many in physics and chemistry going to that nation this year as have to the United States during the twenty-five years of their history.

The University of Göttingen claims the distinction of two of the latest prize winners. Professor Richard Zsigmondy, who has received the 1925 chemistry award, did important work in the development of the ultramicroscope which he utilized in determining the size of the minute suspended particles of colloidal gold. The work for which Dr. James Franck, now at the University of Göttingen, and Dr. Gustav Hertz, of the University of Halle, who divided the 1925 physics prize between them, are best known in scientific circles was performed while they were associated at the University of Berlin. This was the first proof of the validity of the quantum theory, which was proposed originally by Max Planck and has caused a revolution in physical science in recent years, by proposing that light and other forms of radiation are not continuous wave motions, as was formerly thought, but consist of separate bundles or "quanta" of energy.

Franck and Hertz presented their now historic paper before the Berlin Physical Society in 1912. They found that if an otherwise evacuated tube contained a small amount of the vapor of mercury, and that if two pieces of metal or electrodes were sealed within so that the atoms of the vapor could be bombarded by rapidly moving electrons, or particles of electricity, a line corresponding to a certain wave length of light appeared when the glow of the tube was analyzed with the spectroscope. But this only occurred when a definite voltage was applied, which meant that unless the electrons were moving with a certain minimum speed, the particular wave length of light was not given off from the glowing mercury vapor. At the time, Professor Fritz Haber, greatest of German chemists, is said to have remarked that "this paper will be fundamental in the progress of physics," a prediction which has been amply fulfilled.

Dr. Theodor Svedberg, recipient of the 1926 chemistry prize, is an outstanding figure in the realm of colloid chemistry. He was recently invited to come to the United States to attend a symposium on colloid chemistry at the University of Wisconsin, and remained long enough to give a course of lectures to students at that institution. He has since returned to the University of Uppsala in Sweden.

Professor Jean Baptiste Perrin, of the Sorbonne, University of Paris, and winner of the 1926 physics prize, is well known to scientists for work done on the Brownian movement, the name given to the rapid oscillatory motion of minute particles suspended in liquids. Professor Perrin developed ingenious methods for measuring this movement which showed that the tiny particles behave in the



PROFESSOR JEAN BAPTISTE PERRIN
UNIVERSITY OF PARIS, WHO HAS RECEIVED A NOBEL PRIZE IN PHYSICS.

PROFESSOR JAMES FRANCK
UNIVERSITY OF GÖTTINGEN, WHO HAS RECEIVED A NOBEL PRIZE IN PHYSICS.

PROFESSOR GUSTAV HERTZ
UNIVERSITY OF HALLE, WHO HAS RECEIVED A NOBEL PRIZE IN PHYSICS.

PROFESSOR RICHARD ZSIGMONDY
UNIVERSITY OF GÖTTINGEN, WHO HAS RECEIVED A NOBEL PRIZE IN CHEMISTRY.

PROFESSOR THEODOR SVEDBERG
UNIVERSITY OF UPPSALA, WHO HAS RECEIVED A NOBEL PRIZE IN CHEMISTRY.

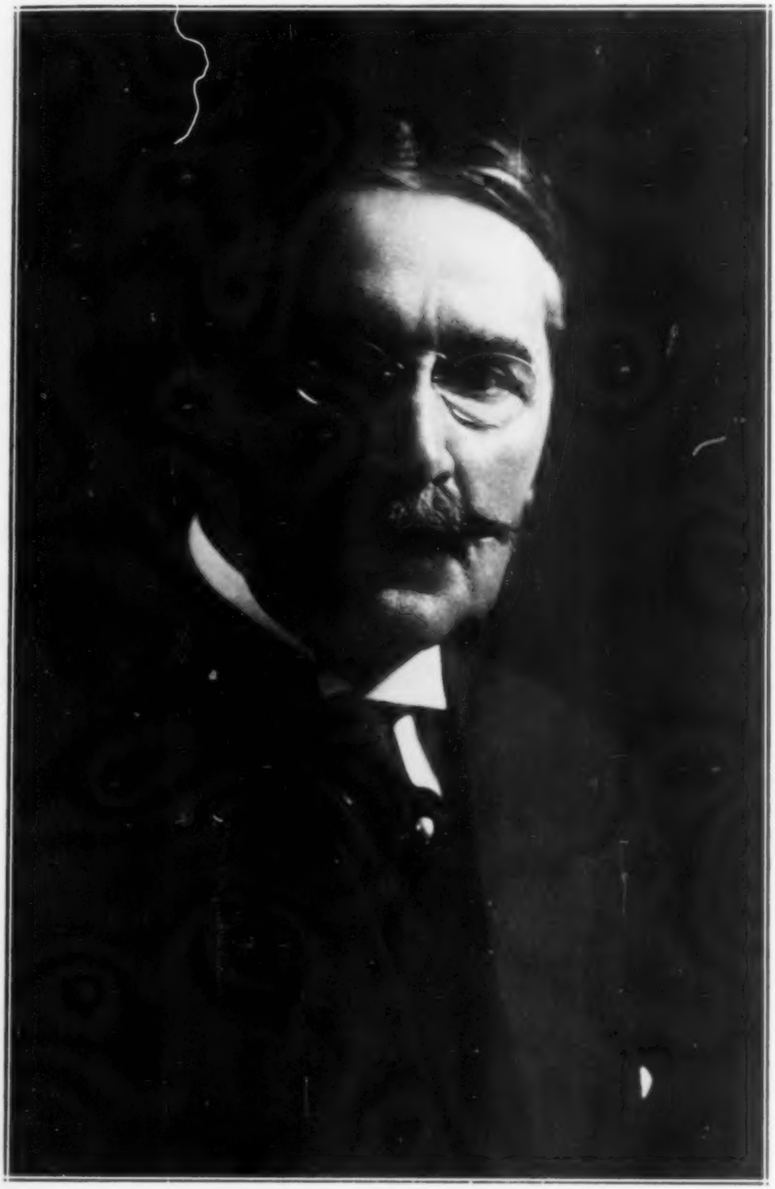
same way scientists have assumed that molecules would act in accordance with the kinetic theory of gases. He has been more recently concerned in studies to show the effect of light on chemical reactions.

MAKING AND UNMAKING MATTER

THE greatest scientific achievement of the nineteenth century, in the opinion of those who lived in that century, was the formulation of two fundamental physical laws of the universe, the conservation of mass and the conservation of energy. According to these matter and energy were immutable in amount and neither could ever be created or destroyed in the minutest measure.

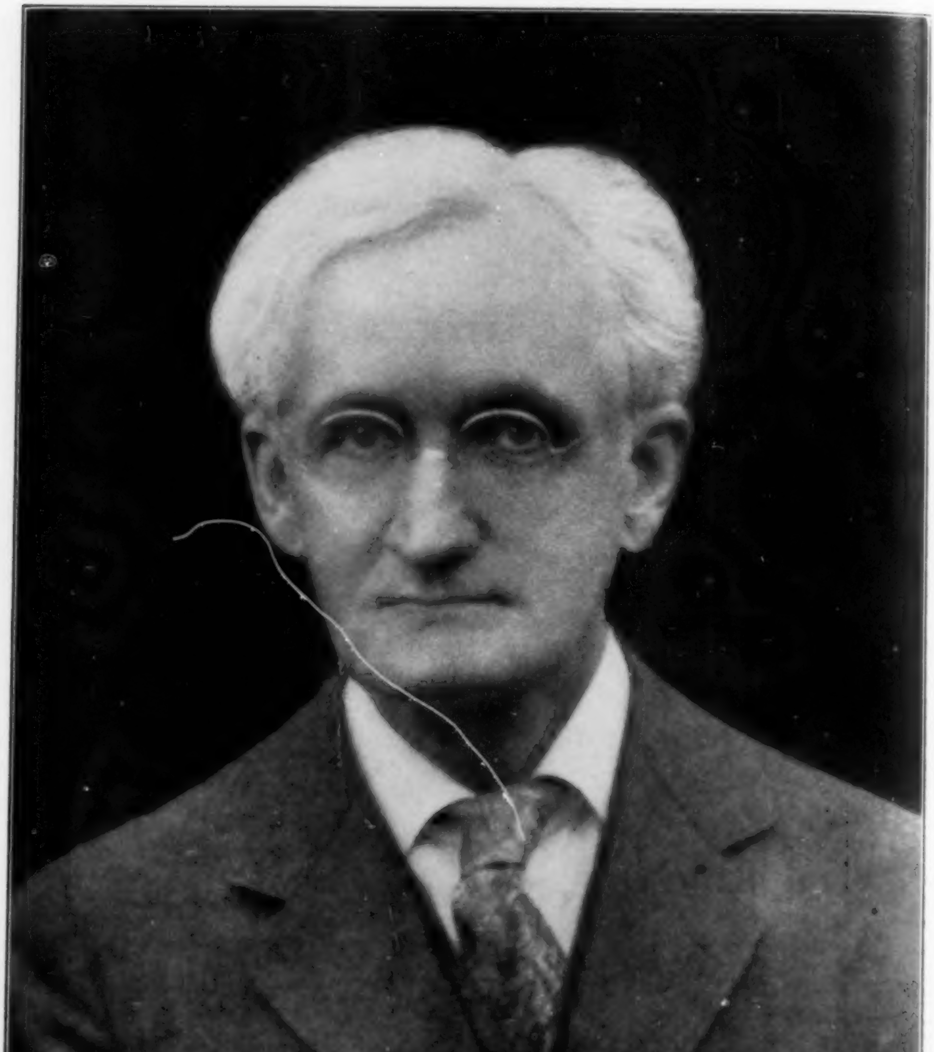
But the twentieth is an unsettling century. Such mental revolutionists as Einstein, Planck and Bohr have opened our eyes and widened our outlook. We can not be so cocksure about many ideas as were the simple-minded scientists of the former century. Some of the generalizations which seemed to them absolute and universal principles of nature appear to the more critical eyesight of the present generation to be disguised definitions; similar, as Eddington puts it, to the great law to which there is no exception, that there are three feet in every yard.

For instance, the law of the conservation of energy. We see a lump of burning coal giving off energy at a great rate as radiant heat and light. Where did that energy come from? Where was it when the lump was cold, if no energy can be created in the course of combustion? The reply of the nineteenth century chemist was clear and decided. The energy was there all the time in exactly the same amount, although its presence could not be demonstrated because it was in the form of "potential energy." Obviously this was unanswerable as an argument, although not very enlightening as an explanation. We are now-a-days disposed to suspect that this "potential energy" was put into the coal by logic rather than by geology, and that if it exists in nature at all it is in the nature of the human mind. The twin laws of conservation of matter and energy are as useful as ever, for they still serve to clarify our conceptions and to guide our experimentation. No experiment has ever been able to detect the slightest flaw in them, and it may never be possible to devise tests so delicate as to disclose any discrepancy. Yet neither law is now regarded as absolute in itself and it seems that we shall have to substitute a general law which will include the two and allow for the transformation of matter into energy and *vice versa*. Einstein has worked out the formula for the equivalence of matter and energy, so we can now calculate how much heat will be produced if a certain mass of matter is annihilated. This idea has been welcomed by the astronomers who have long been hard put to it to devise means of keeping up the furnace fires of the sun as long as mankind would like to live. They have now figured out by Einstein's formula that the sun is losing weight through the destruction of its material and the emission of immaterial energy at the rate of four million tons a second. But even though wasting away at this appalling rate the sun can hold out for ten million million years. This gives a welcome extension of time for the life of our world and permits us to hope that we may get our social system perfected before we all become Eskimos.



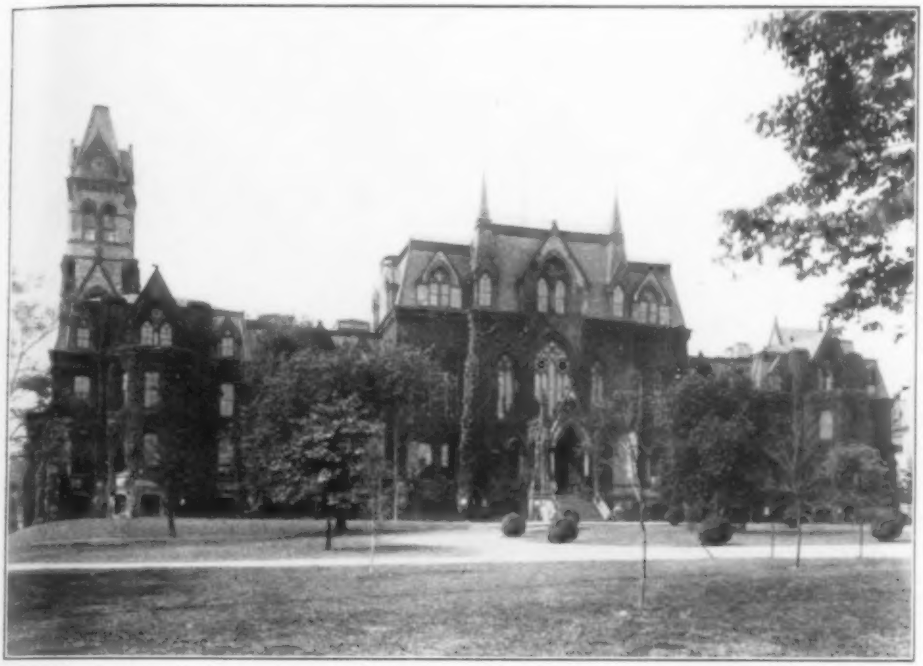
DR. MICHAEL I. PUPIN

Professor of electromechanics at Columbia University, retiring president of the American Association, who will give the annual address on "Fifty Years' Progress in Electrical Communication."



DR. LIBERTY HYDE BAILEY

FORMERLY DIRECTOR OF THE NEW YORK STATE COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY, PRESIDENT OF THE ASSOCIATION.



COLLEGE HALL

CONTAINING THE ADMINISTRATIVE OFFICES AND OFFICES AND CLASSROOMS OF THE COLLEGE, THE SCHOOL OF EDUCATION AND THE GRADUATE SCHOOL.

THE PHILADELPHIA MEETING OF THE AMERICAN ASSOCIATION AND ASSOCIATED SOCIETIES

BY DR. BURTON E. LIVINGSTON

Permanent Secretary of the American Association

THIS year's convention of the American Association for the Advancement of Science and a large group of scientific societies that meets with it will occur in Philadelphia, from Monday, December 27, to Saturday, January 1. This will be the fifth time the association has met in Philadelphia. It was founded in that city in 1848. Twelve years have passed since the fourth Philadelphia meeting.

The president for this year's convention is Dr. L. H. Bailey, whose scientific work is well known to botanists and horticulturists. He was for many years dean and director of the New York State College of Agriculture at Cornell University. The rapid and permanent development of that college was due largely to his broad foresight. Dr. Bailey is this year president also of the Botanical Society of America. He was president of the International Congress of Plant Sciences, held at Cornell University last August. He is at present engaged especially in a special study of the palms. He has written much on rural economics and in kindred fields.

The retiring president of the association is Dr. Michael I. Pupin, professor of electromechanics in Columbia University, known far beyond the limits of his scientific field, especially on account of his autobiography, "From Immigrant to Inventor," for which he received the

DR. BURTON E. LIVINGSTON

PROFESSOR OF PLANT PHYSIOLOGY IN THE JOHNS HOPKINS UNIVERSITY, PERMANENT SECRETARY OF THE AMERICAN ASSOCIATION.

Pulitzer Prize. His discoveries and inventions are everywhere in use in cable telephones and radio apparatus. The retiring president of the association always gives the principal address at the opening session of the annual meeting, on the evening of the first day. Dr. Pupin's address will be on "Fifty Years' Progress in Electrical Communication."

The meeting at Philadelphia is to be open to all who wish to attend. Besides the fifteen sections of the American Association, each representing one of the branches of science, there will be meetings of thirty-nine independent scientific organizations in many special fields, with addresses and papers bearing on almost every topic of scientific research. Every evening and every afternoon there will be general sessions devoted to papers and addresses of a general nature, by eminent men of science. Among these addresses will be one on "Cambridge University," with illustrations, by Professor George H. F. Nuttall, director of the Molteno Institution for Research in Parasitology, Cambridge University, Cambridge, England. Another will be on "Geographic Conditions of Ancient Greek Culture," by Dr. J. L. Myers, general secretary of the British Association for the Advancement of Science. Mr. Herbert Hoover will give the annual Sigma Xi lecture at a joint session of the Association and the Society of Sigma Xi, on Tuesday evening, December 28. Mr. Hoover's address is entitled "The Nation and Science."

A new feature of the work of the association in connection with the annual meetings is to be inaugurated this year at Philadelphia; namely, an attempt to bring some of the atmosphere of science and of the meeting to the youth of the city, by means of non-technical lectures and demonstrations on science subjects. Four evening lectures will be given in one of the high-school buildings and tickets are to be issued beforehand to the high-school students.

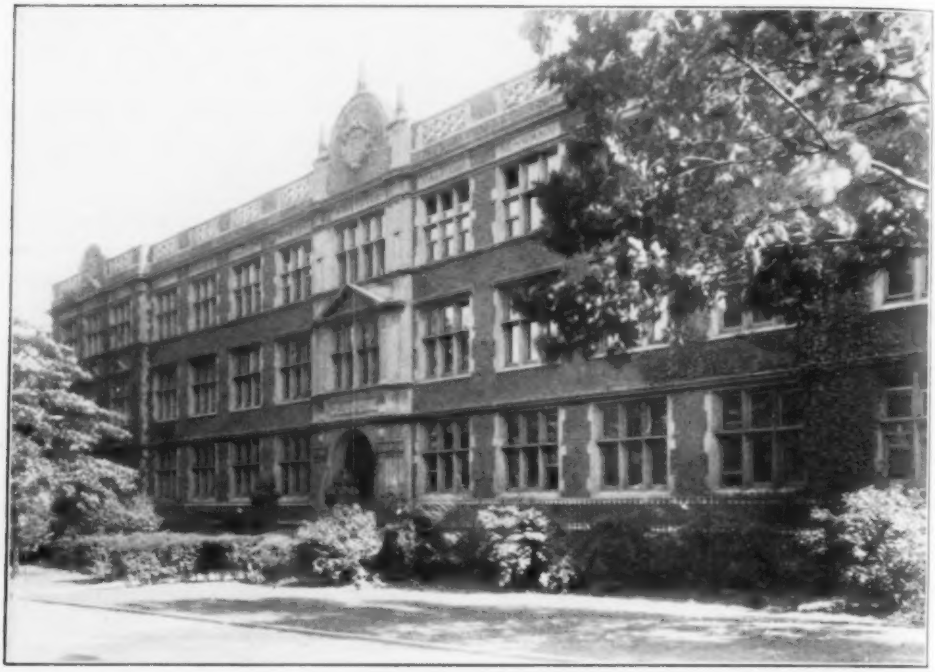
The University of Pennsylvania, the Franklin Institute, the American Philosophical Society and the Drexel Institute are very generously throwing their rooms open for the use of the convention. Most of the sessions will be held in the buildings of the university.

The annual science exhibition will this year be larger and more comprehensive than any earlier one. It will be housed in the gymnasium of the University of Pennsylvania. Many commercial firms will exhibit their apparatus, products and books, and there will be invited exhibits from individual scientists and research laboratories. Besides the general exhibition, many of the societies meeting with the association will hold smaller and more restricted exhibitions, showing recent progress in their respective fields. The general exhibition will be the social center of the meeting. Tea will be served there every afternoon and there will be special entertainments on some of the evenings, including one on New Year's Eve.

Those who attend the Philadelphia convention will have the advantage of reduced railway rates, on the certificate plan. When purchasing tickets to Philadelphia, each purchaser should secure a certificate for the meeting of the American Association for the Advancement of Science and Associated Societies. After validation at the meeting, the certificate will entitle the holder to a half-fare rate for the return trip.

The general program of the meeting will be available on Monday, December 27, and throughout the week, for all who register. Members of the association who do not attend the meeting may secure copies of the program by addressing the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C. The program will be a book of about 250 pages.

The fourth annual American Association Prize, of one thousand dollars, will be awarded at Philadelphia, to the au-



THE ZOOLOGICAL LABORATORIES

IN WHICH MANY OF THE SECTIONS DEVOTED TO THE BIOLOGICAL SCIENCES WILL HOLD MEETINGS.

thor of a notable contribution to the advancement of science presented at the meeting. The award of the annual prize has become an important feature of the meetings of the association. These prizes are made possible through the generosity of a member who wishes his name withheld.

Science Service and other organizations for the distribution of science news will be represented at the Philadelphia convention, as well as many daily newspapers. Preparations have been made for excellent news service, and the daily press throughout the country will be well supplied with material for publication. The newspapers will carry to their readers many interesting and well-written accounts of the many features of the meeting and of the scientific discoveries reported at the numerous sessions.

During the week of the convention those in attendance will receive mail and telegrams addressed to them in the care of the American Association, Registration Office, Weightman Hall, the University of Pennsylvania, Philadelphia, Pa.

Preliminary announcements of the Philadelphia meeting and other information about the American Association have appeared in recent issues of *Science*, especially in the issue for December 3rd. Copies of the special issue may be secured from the office of the permanent secretary, who also supplies a booklet on the organization and work of the association. All who are interested in any way in the advancement of knowledge are invited to membership. Although the majority of the members are of the United States and Canada yet the field of the American Association is not limited to those two countries and it has members in all parts of the world.

The photograph of Dr. Friedrich von Müller which was reproduced in the December number of THE SCIENTIFIC MONTHLY was loaned to us by Dr. Victor Robinson, editor of *Medical Life*.